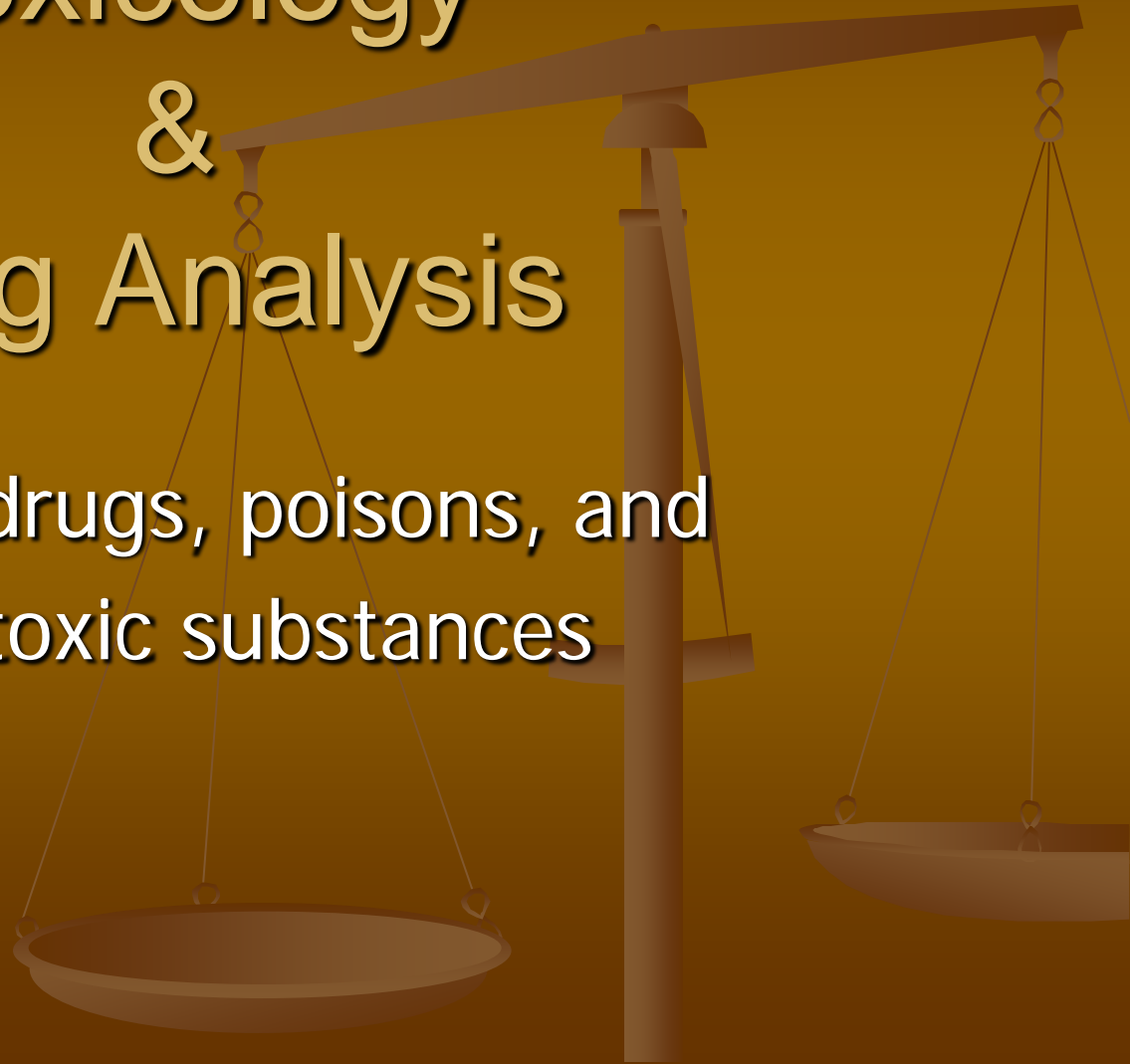


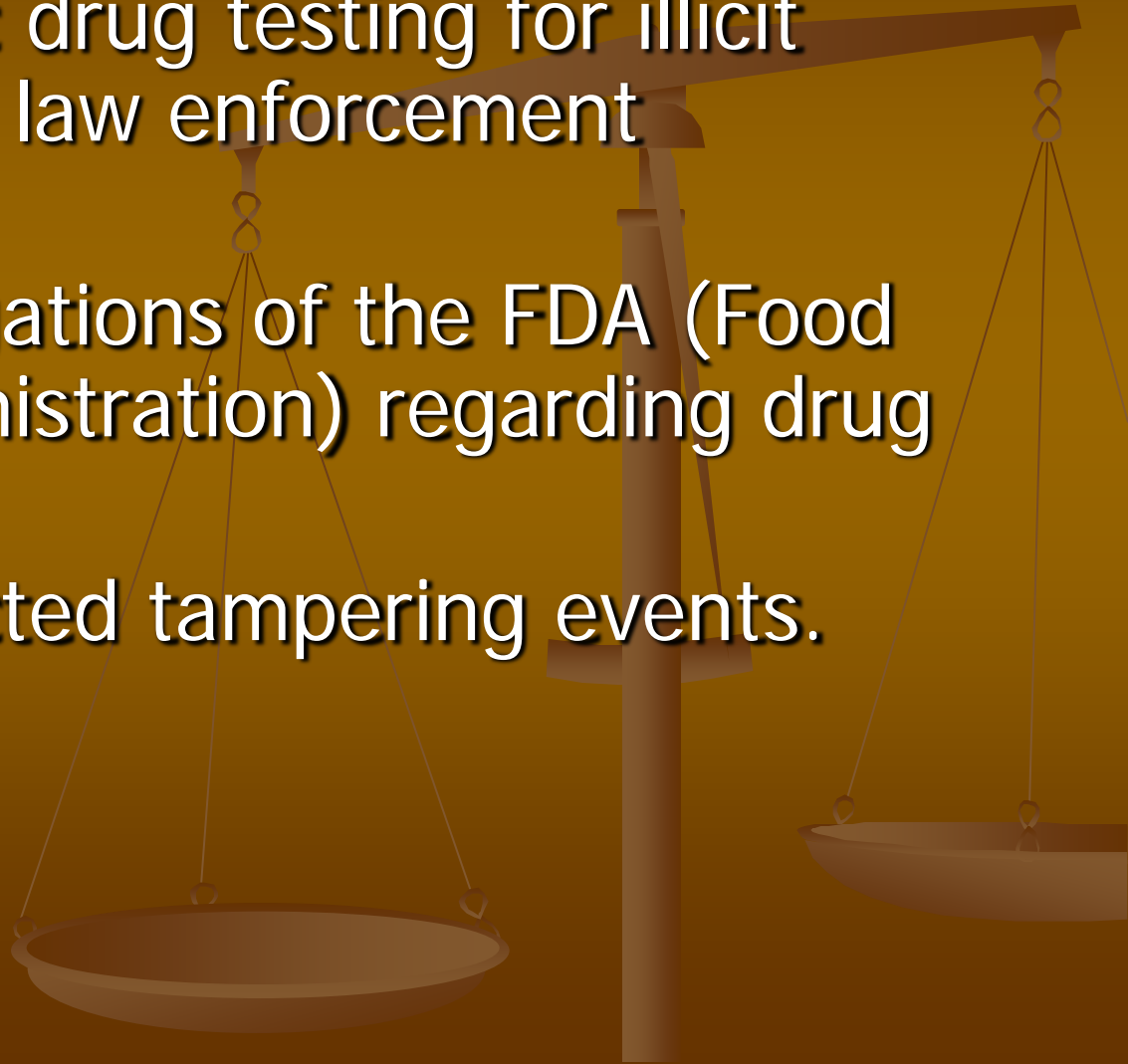
# Toxicology & Drug Analysis

Study of drugs, poisons, and  
other toxic substances



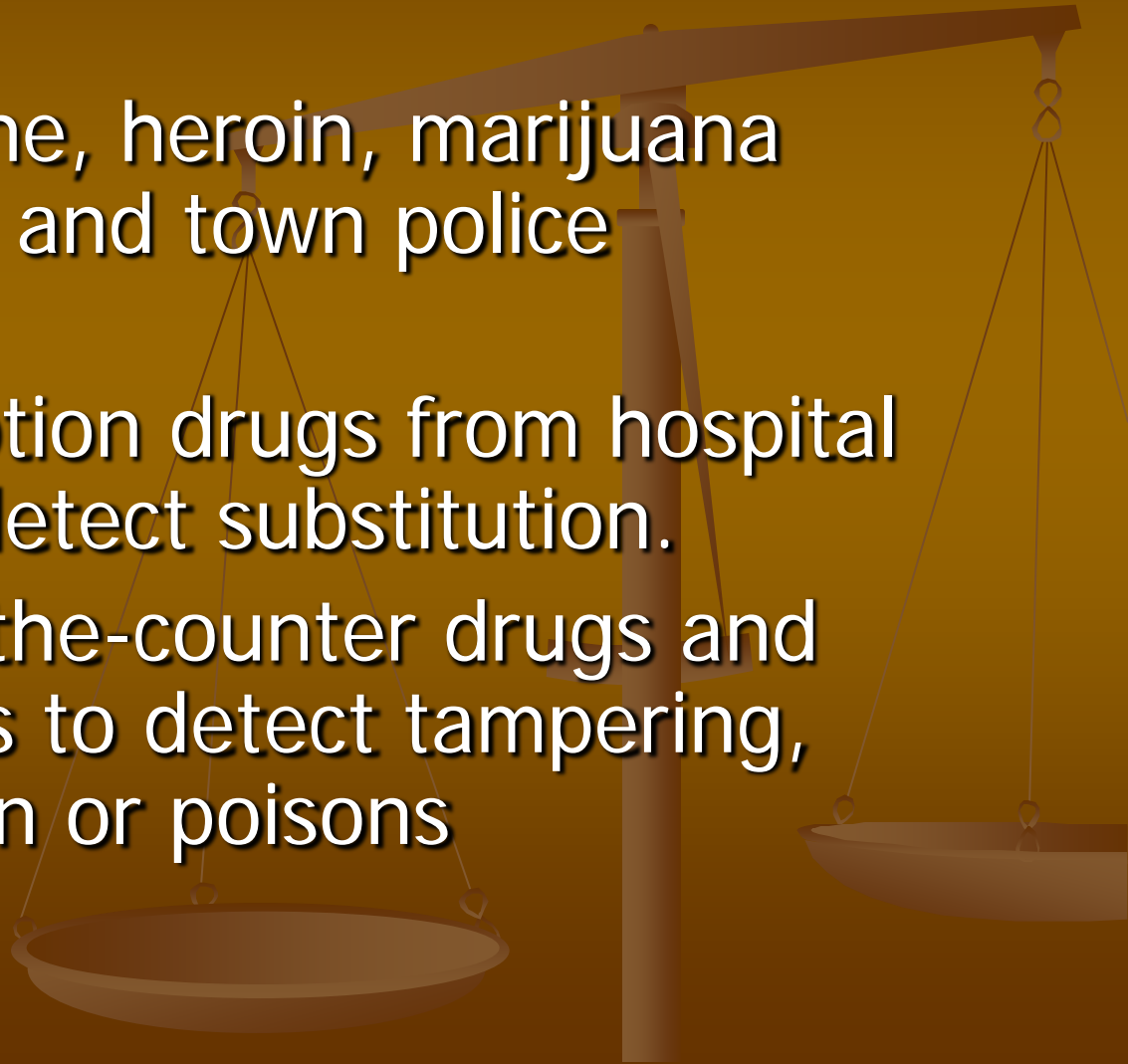
# Drug Analysis Labs

- provide forensic drug testing for illicit drugs seized by law enforcement agencies,
- support investigations of the FDA (Food and Drug Administration) regarding drug diversions,
- evaluate suspected tampering events.



# Examples of services are:

- Analyzing cocaine, heroin, marijuana seizures for city and town police departments.
- Testing prescription drugs from hospital pharmacies to detect substitution.
- Analyzing over-the-counter drugs and alcohol products to detect tampering, including dilution or poisons

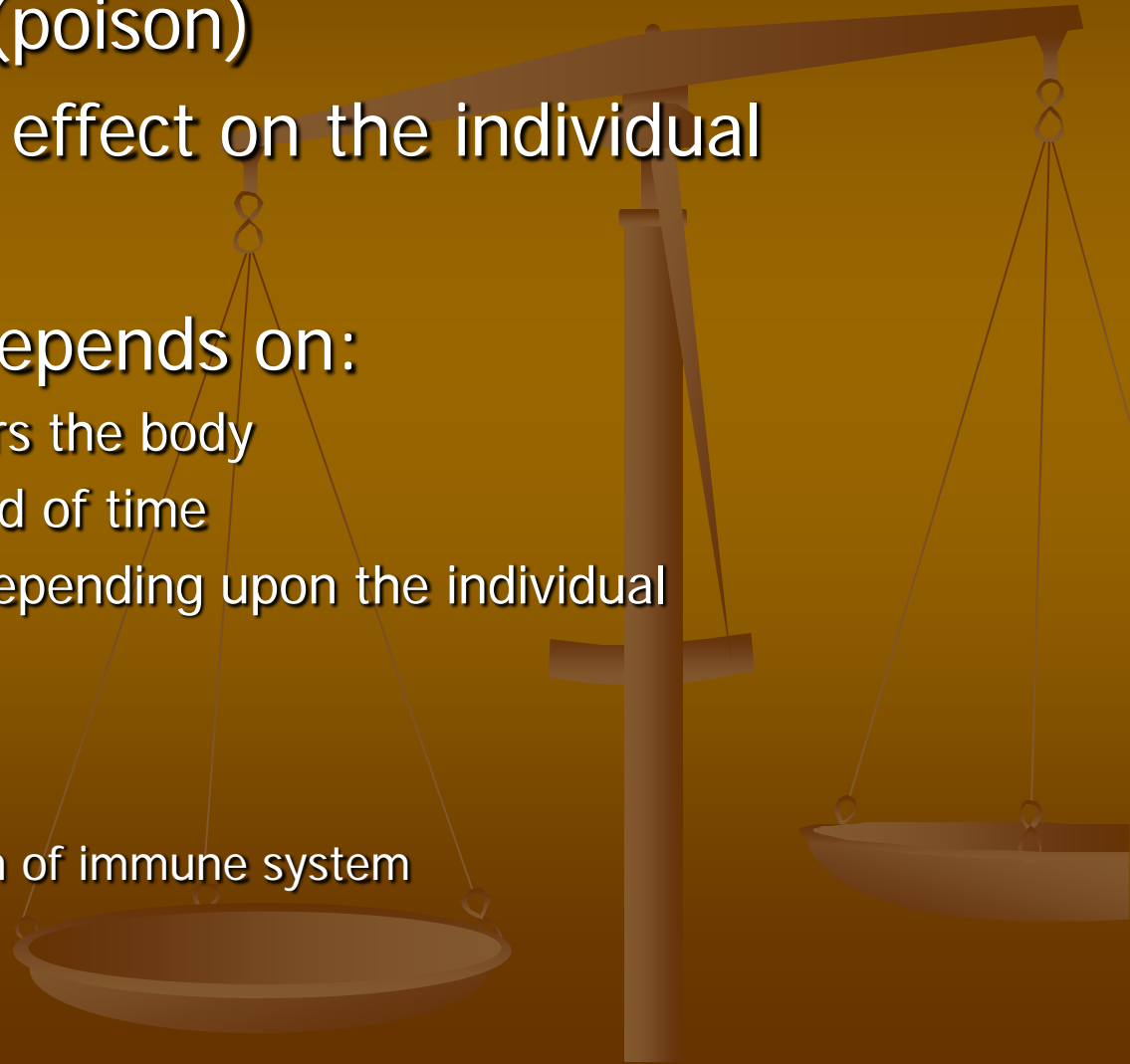


# Job of Toxicologist

- a) Identify a toxin (poison)
- b) Determine likely effect on the individual

## Degree of Toxicity depends on:

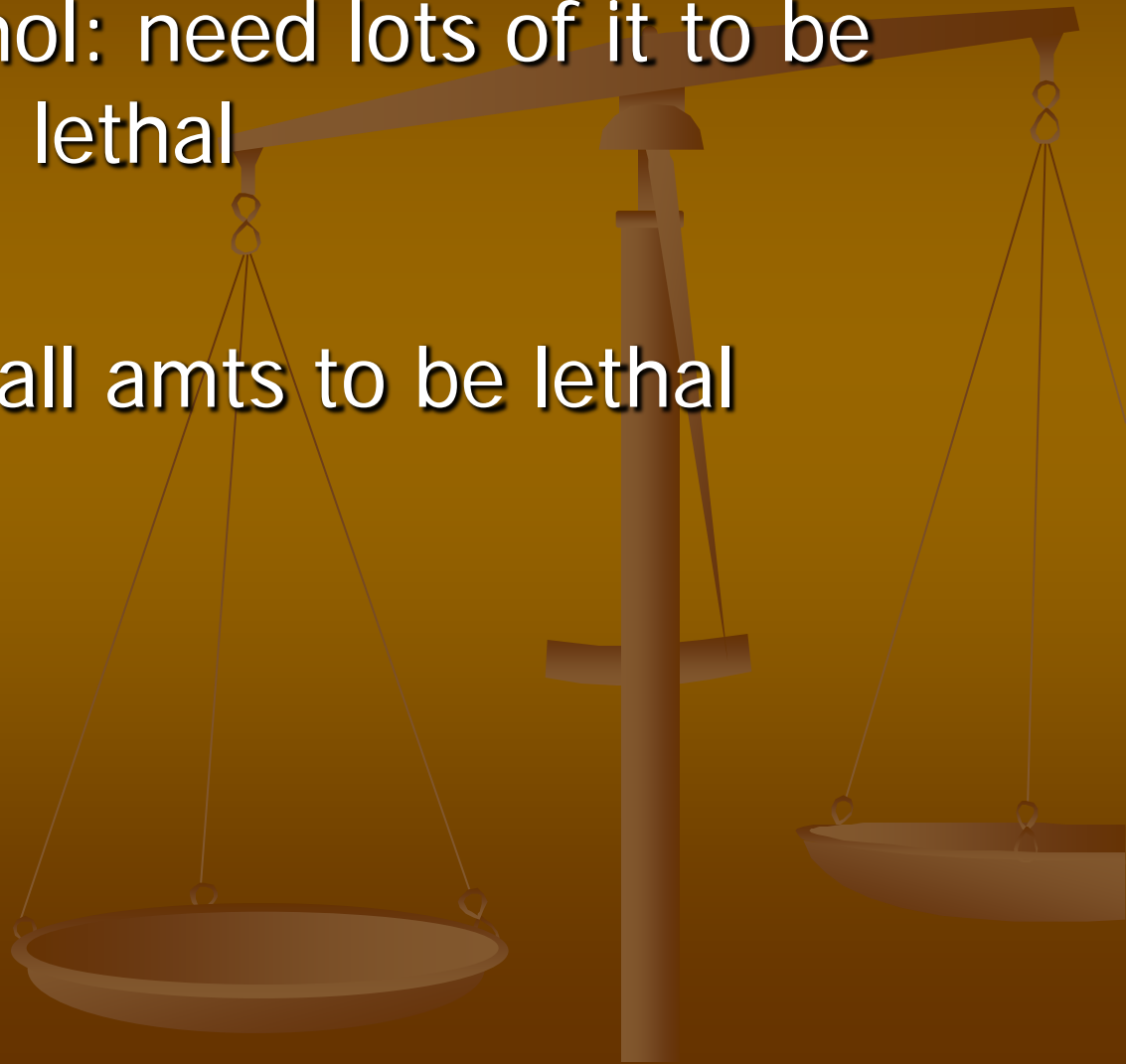
- How much enters the body
- Over what period of time
- Other factors, depending upon the individual
  - Body size
  - Age
  - Tolerance
  - General health of immune system



# Intoxicant vs poison

Intoxicant - alcohol: need lots of it to be lethal

Poison – need small amts to be lethal

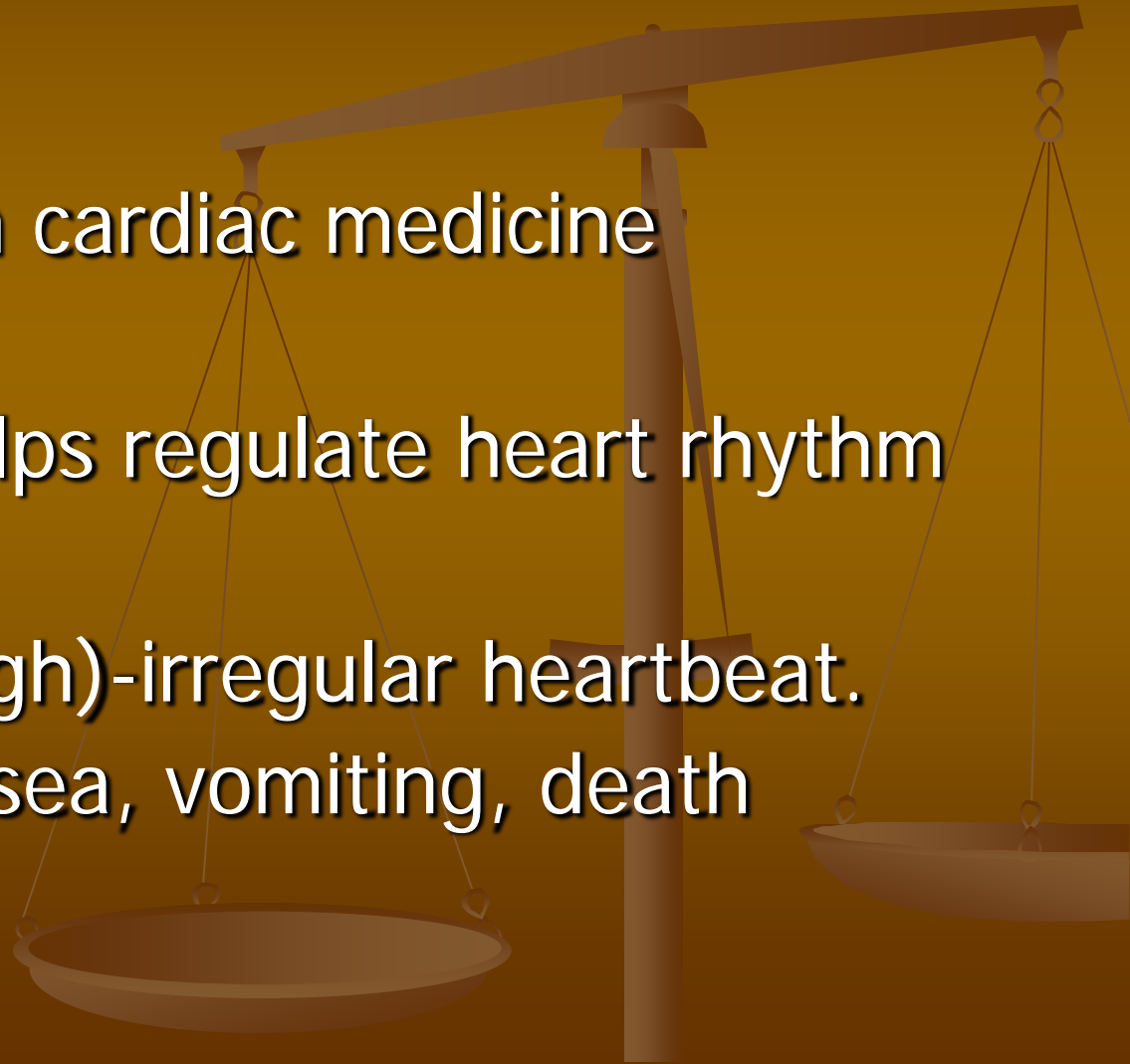


# Right dose/wrong dose

## EXAMPLE:

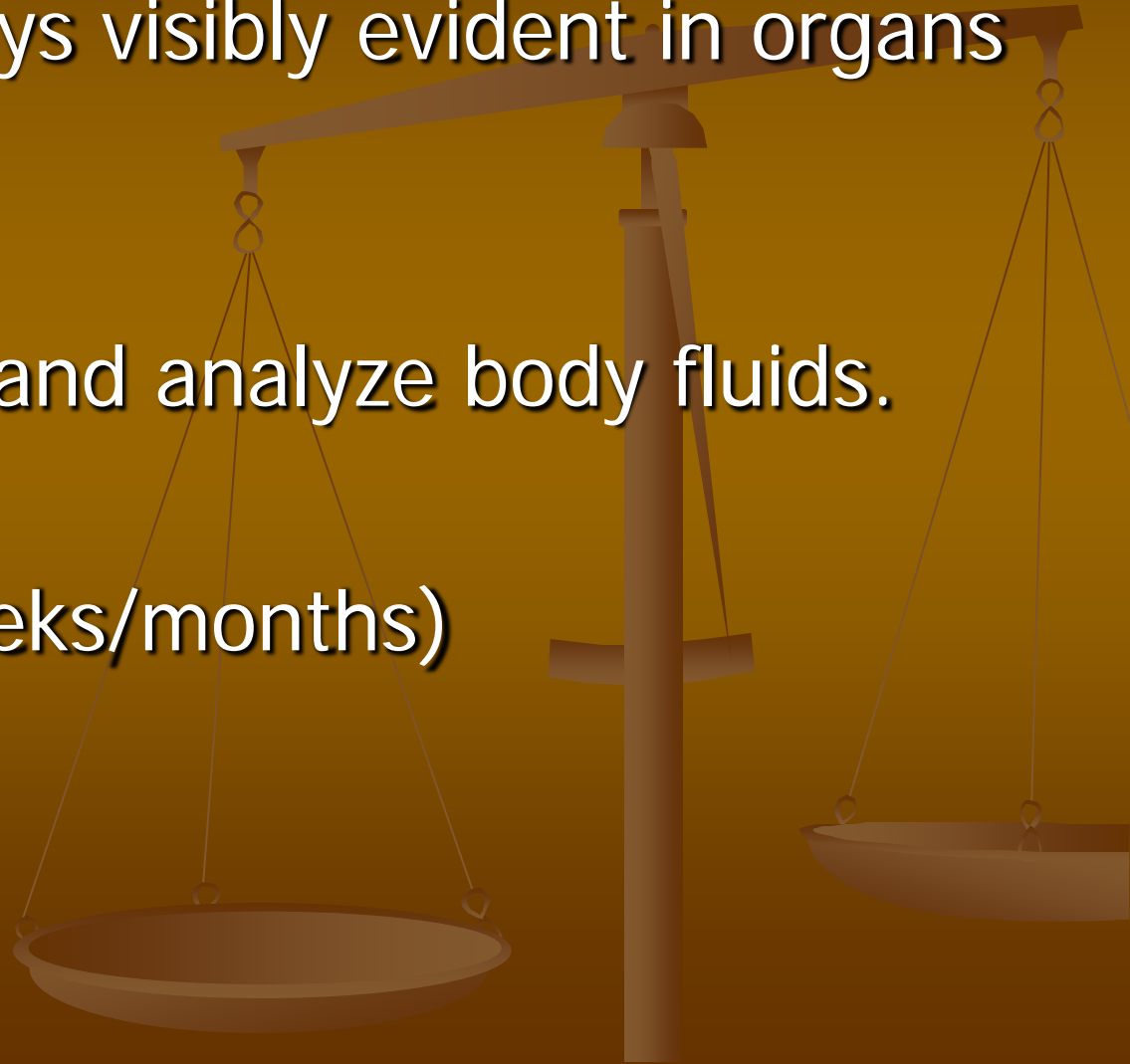
Digitalis- common cardiac medicine

- Right dose... helps regulate heart rhythm
- Wrong dose (high)-irregular heartbeat.  
leads to nausea, vomiting, death



# Autopsy

- Toxins not always visibly evident in organs or tissues.
- Need to collect and analyze body fluids.
- Takes time (weeks/months)



# metals

In excess, these metals can be harmful/fatal

iron

mercury

lead

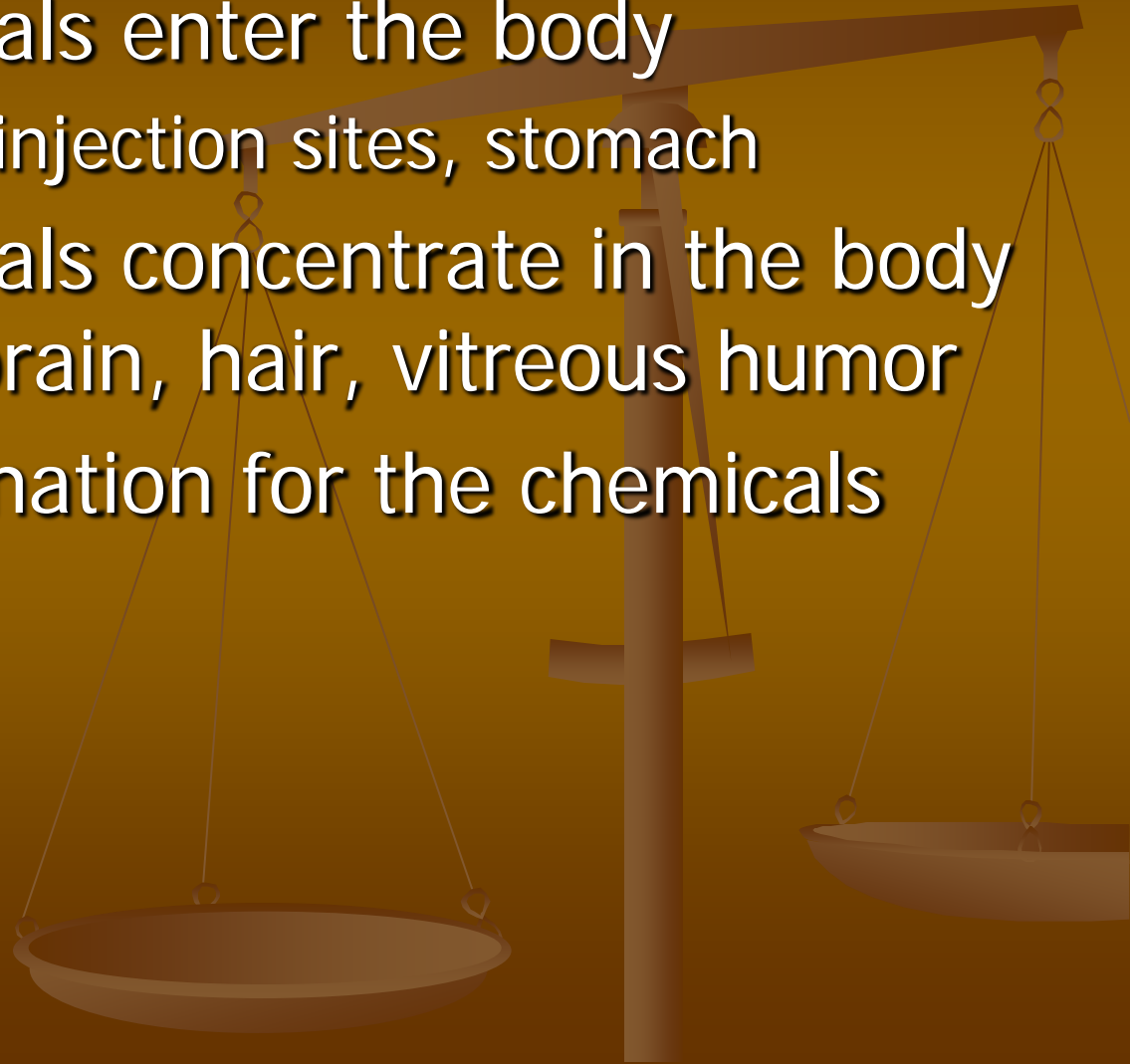
copper





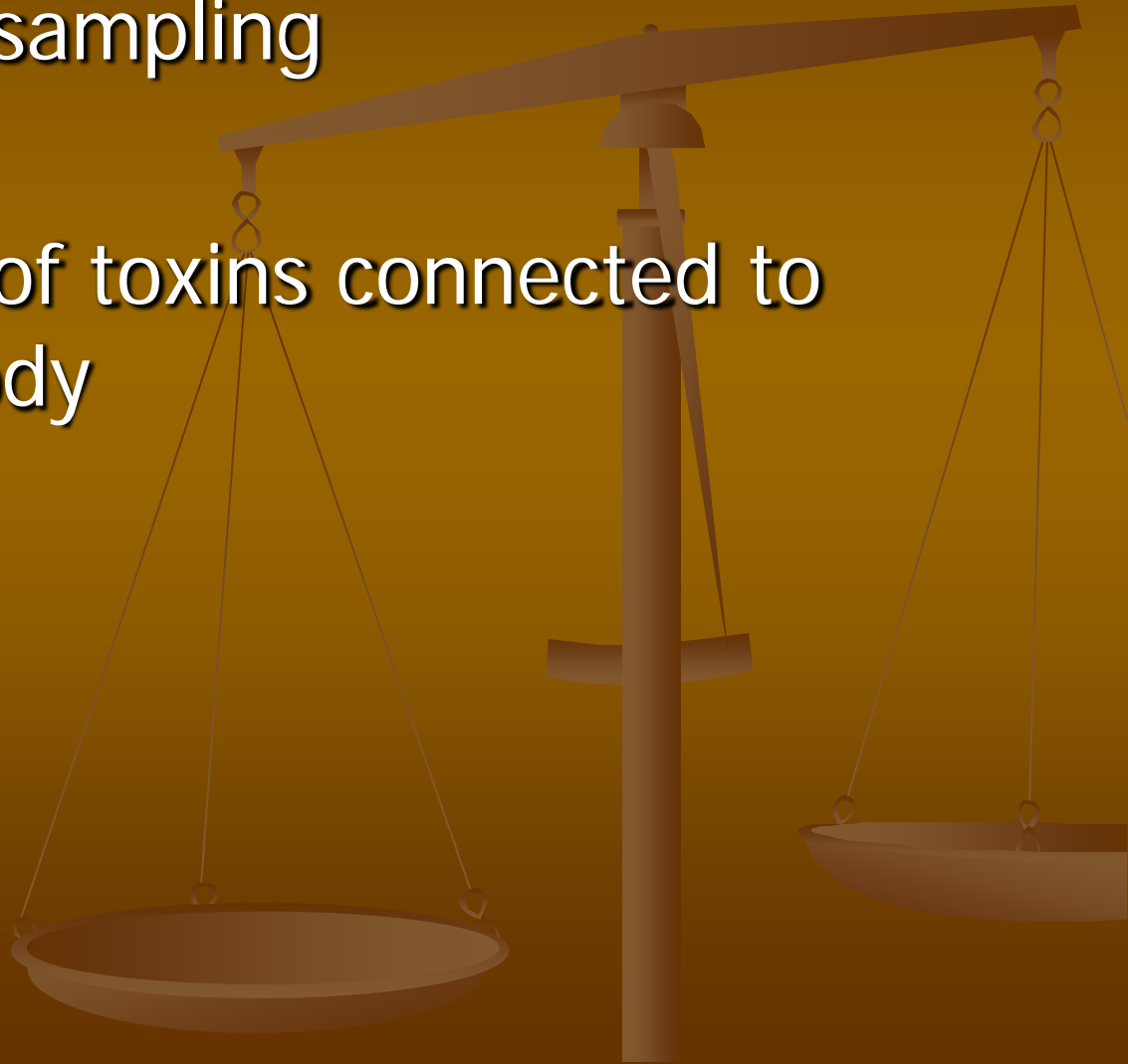
# Get samples from:

- a) Where chemicals enter the body
  - blood, injection sites, stomach
- b) Where chemicals concentrate in the body
  - liver, brain, hair, vitreous humor
- c) Route of elimination for the chemicals
  - urine



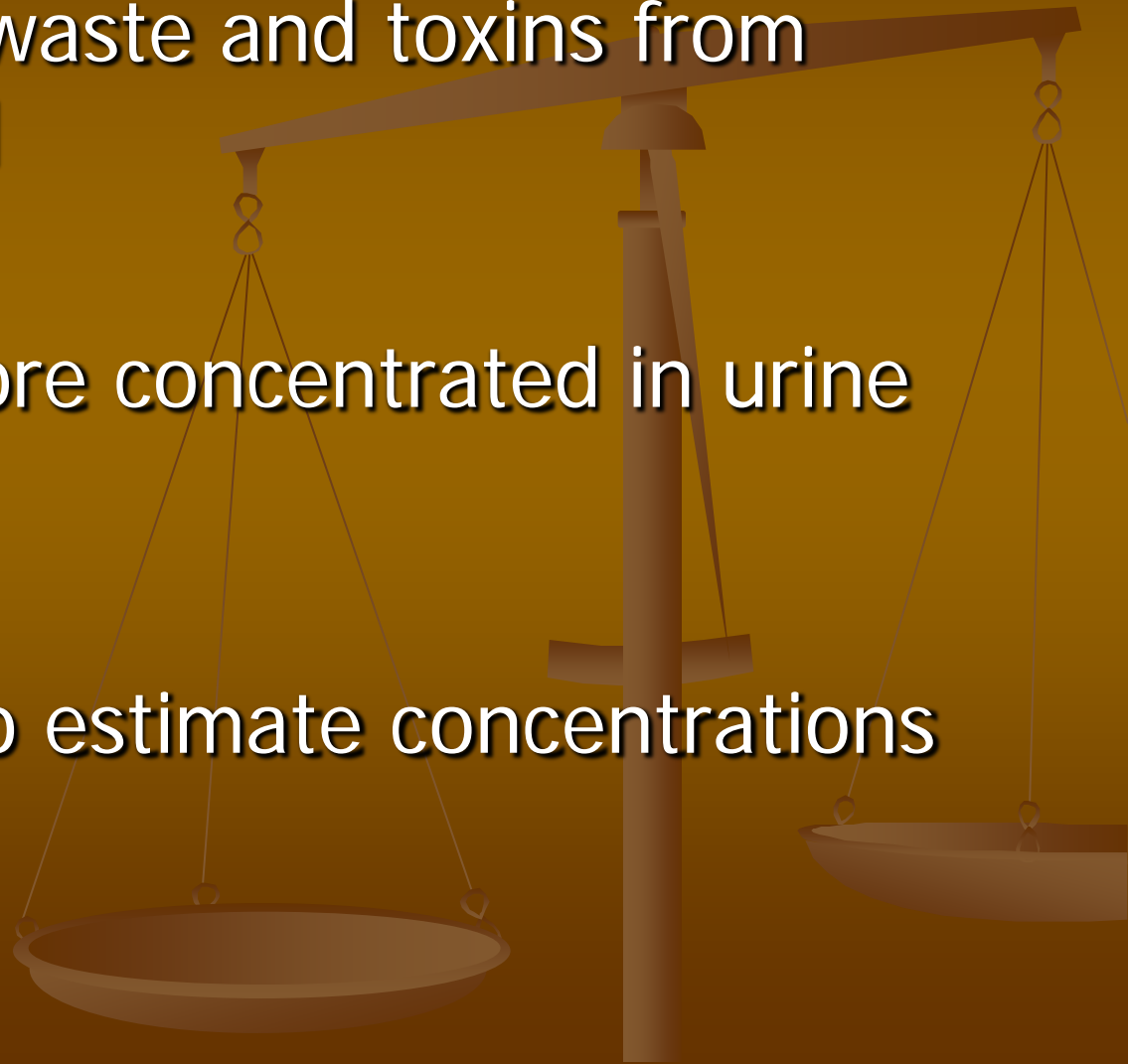
# Blood

- Most useful for sampling
- Concentrations of toxins connected to effect on the body



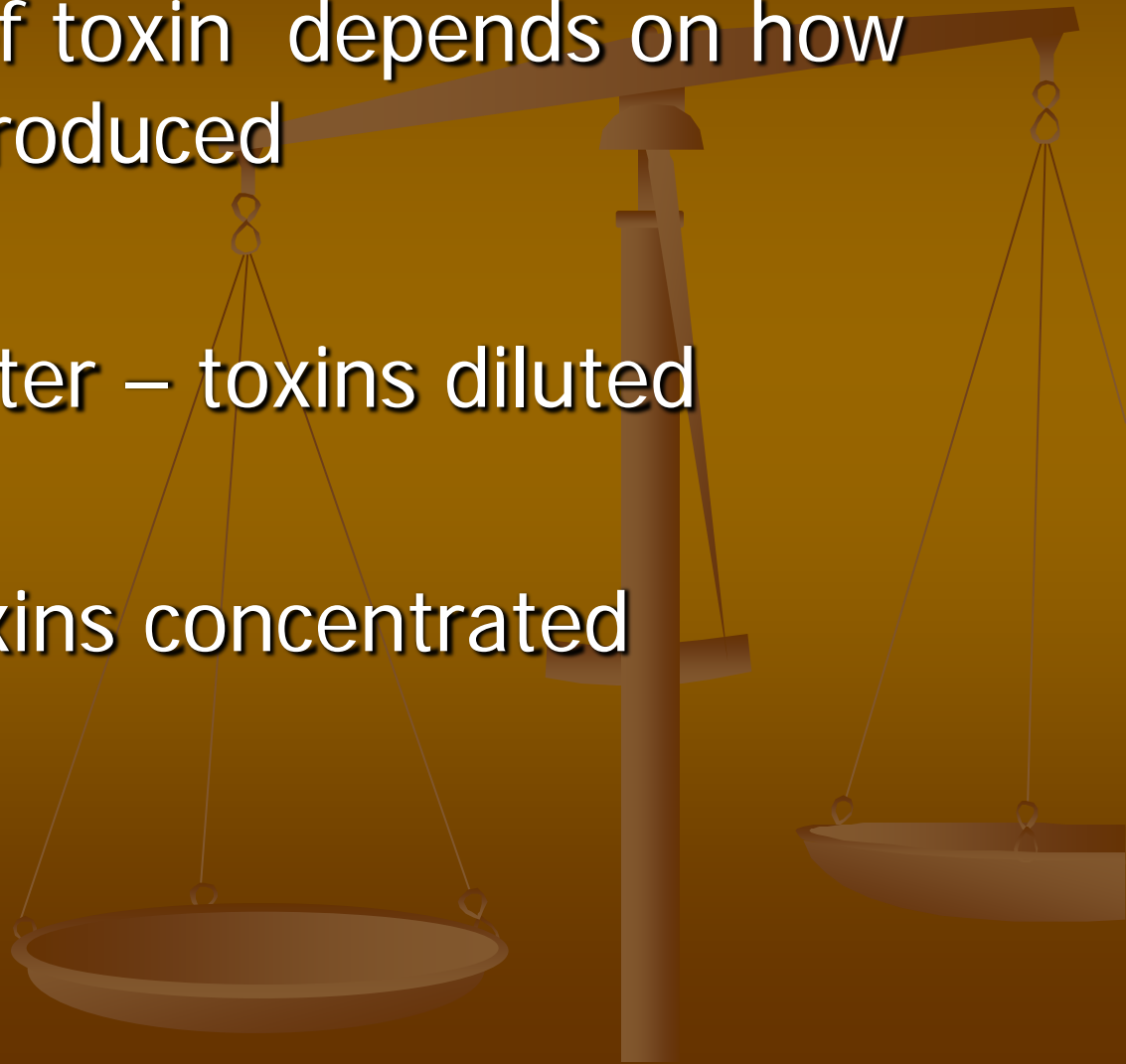
# Urine

- Kidneys -filter waste and toxins from blood
- Toxins often more concentrated in urine than in blood
- Can't be used to estimate concentrations in blood



# In the Urine...

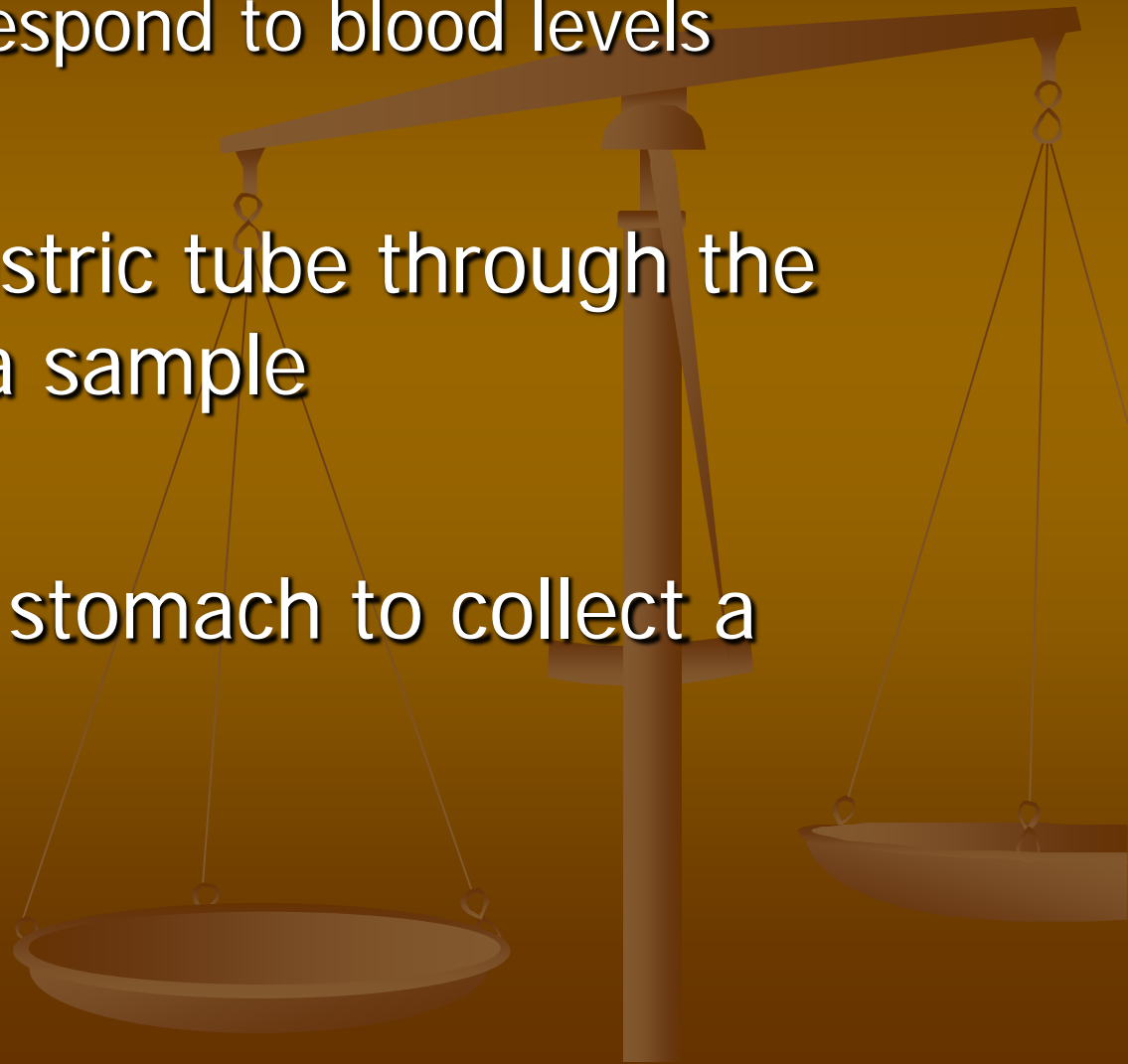
- Concentration of toxin depends on how much urine is produced
- Drink lots of water – toxins diluted
- Dehydrated- toxins concentrated



# Stomach contents

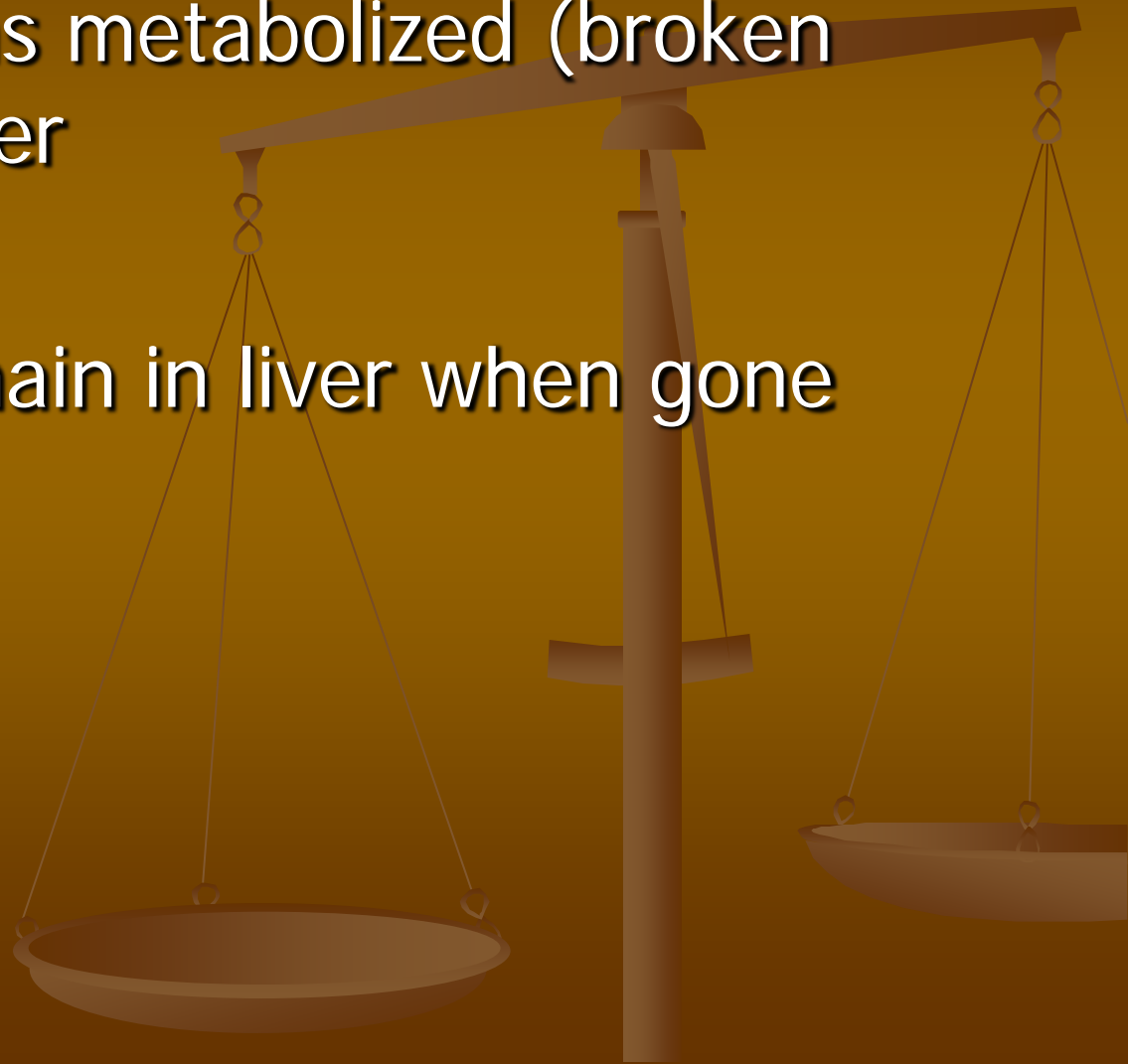
Toxins don't correspond to blood levels

- Living- use a gastric tube through the nose to collect a sample
- Dead – cut into stomach to collect a sample



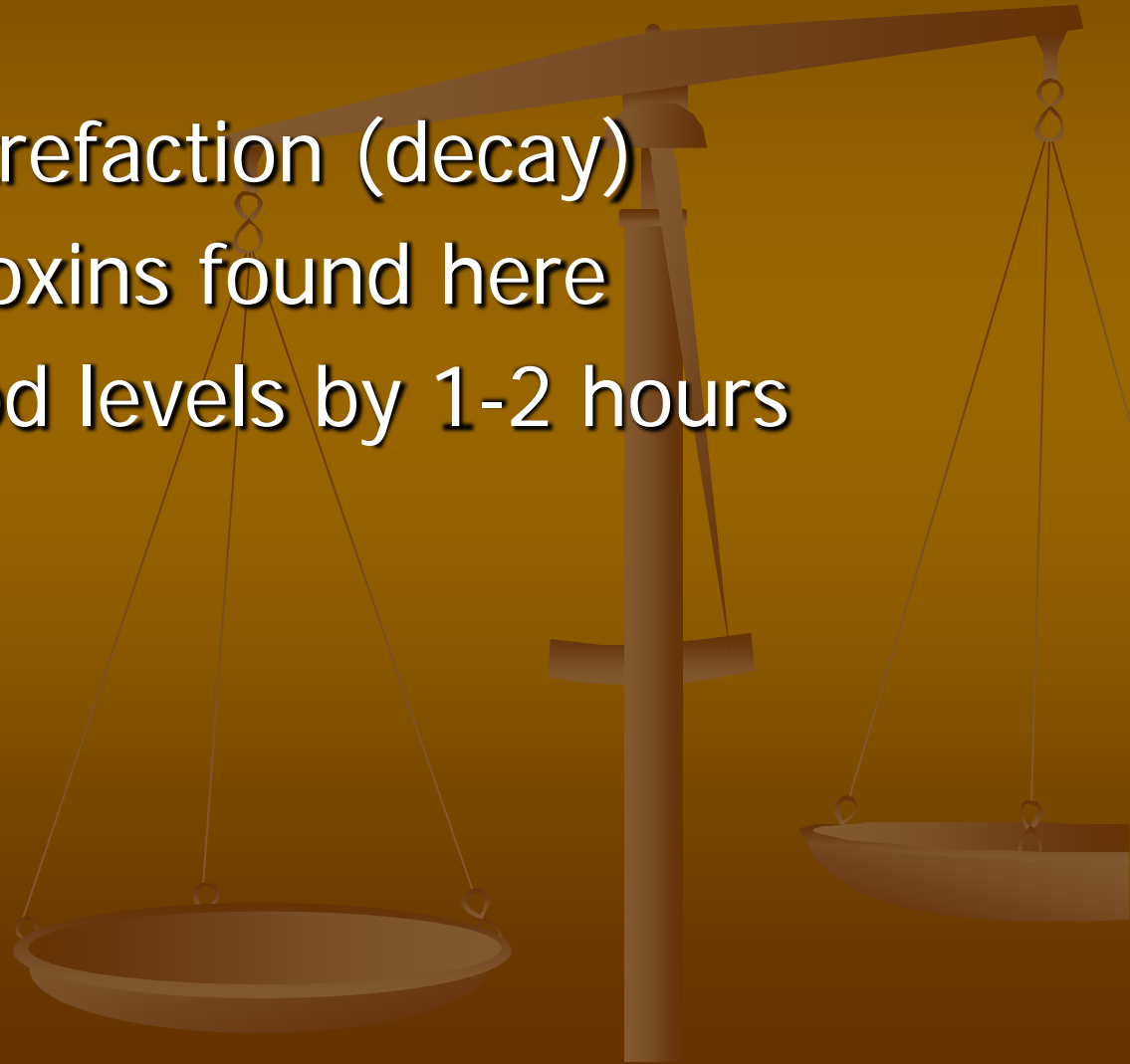
# Liver

- Drugs and toxins metabolized (broken down) in the liver
- Toxins may remain in liver when gone from blood



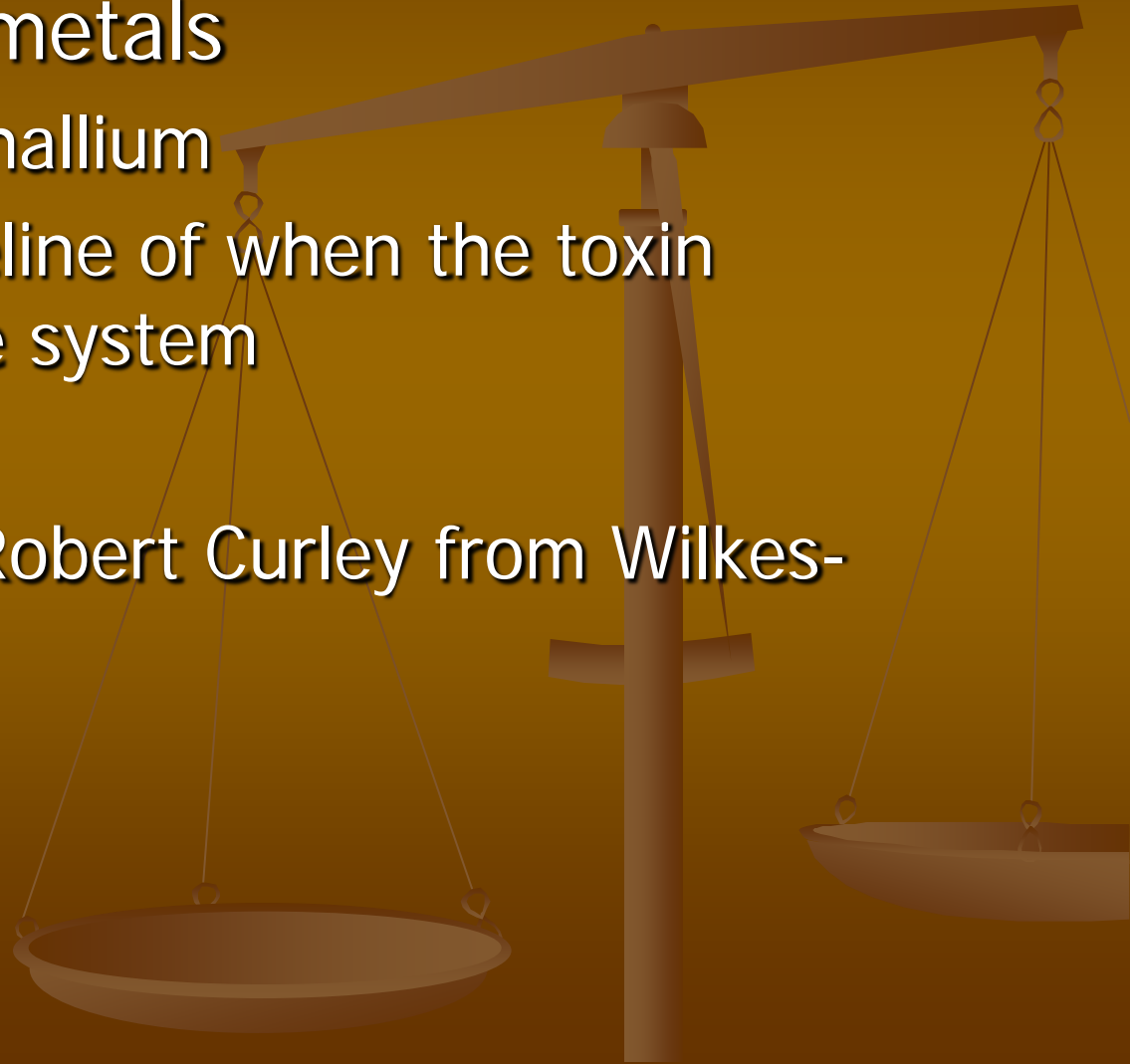
# Vitreous humor

- Liquid in eye
- Resistant to putrefaction (decay)
- Water-soluble toxins found here
- Lag behind blood levels by 1-2 hours



# Hair

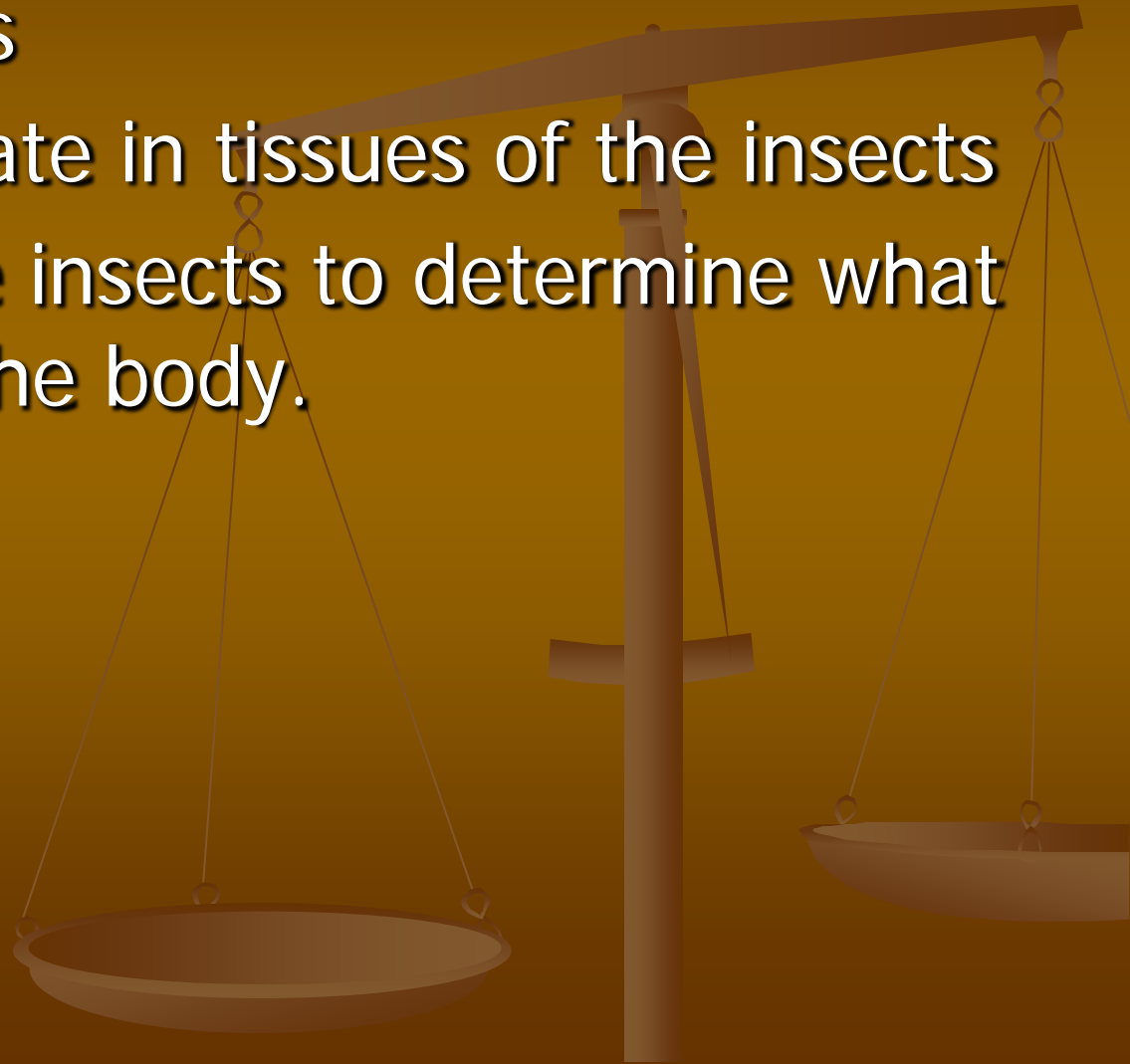
- Absorbs heavy metals
  - Arsenic, lead, thallium
  - Can give a timeline of when the toxin appeared in the system
- Famous case: Robert Curley from Wilkes-Barre





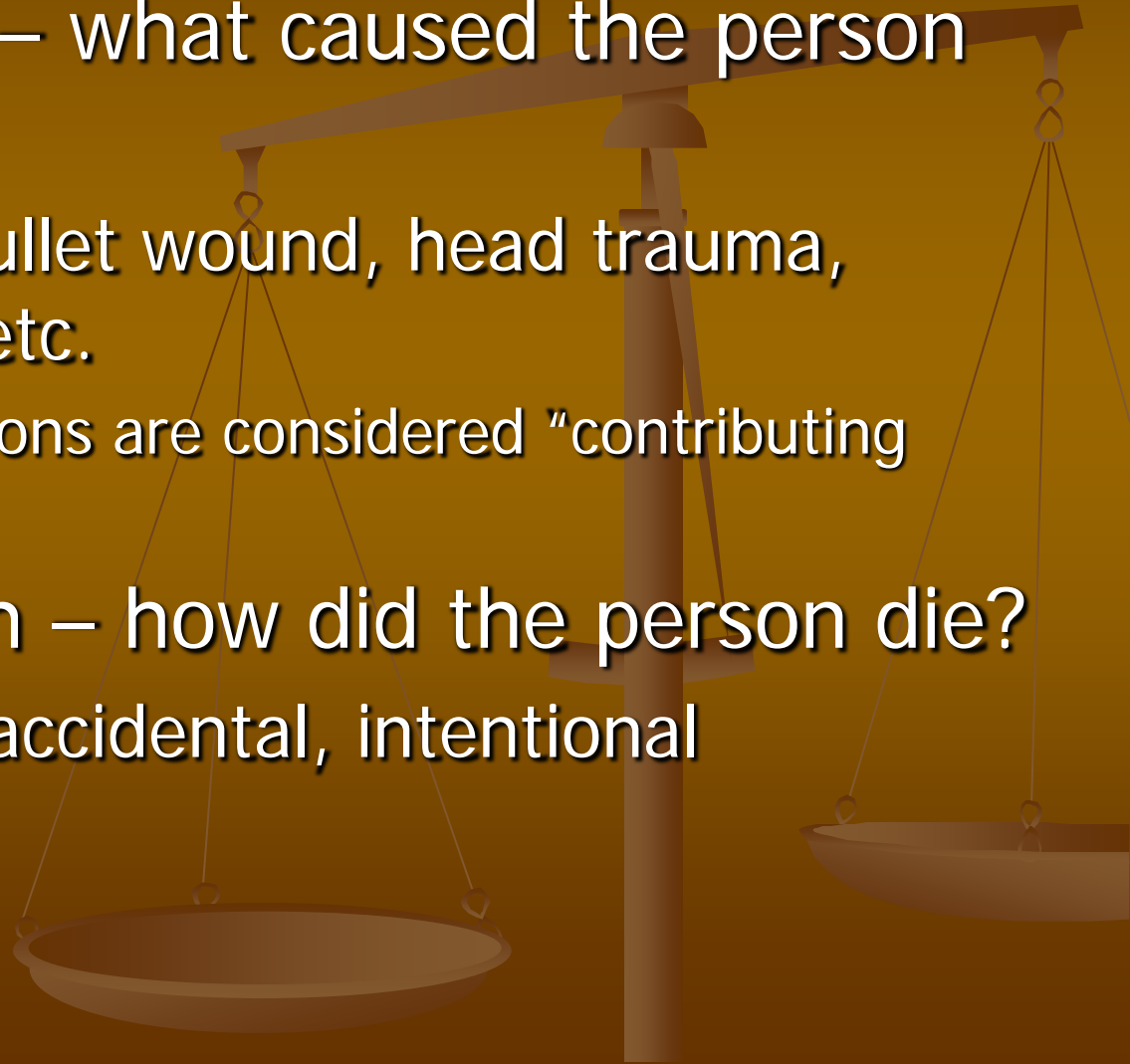
# Insects

- Feed on corpses
- Drugs concentrate in tissues of the insects
- Can analyze the insects to determine what toxins were in the body.



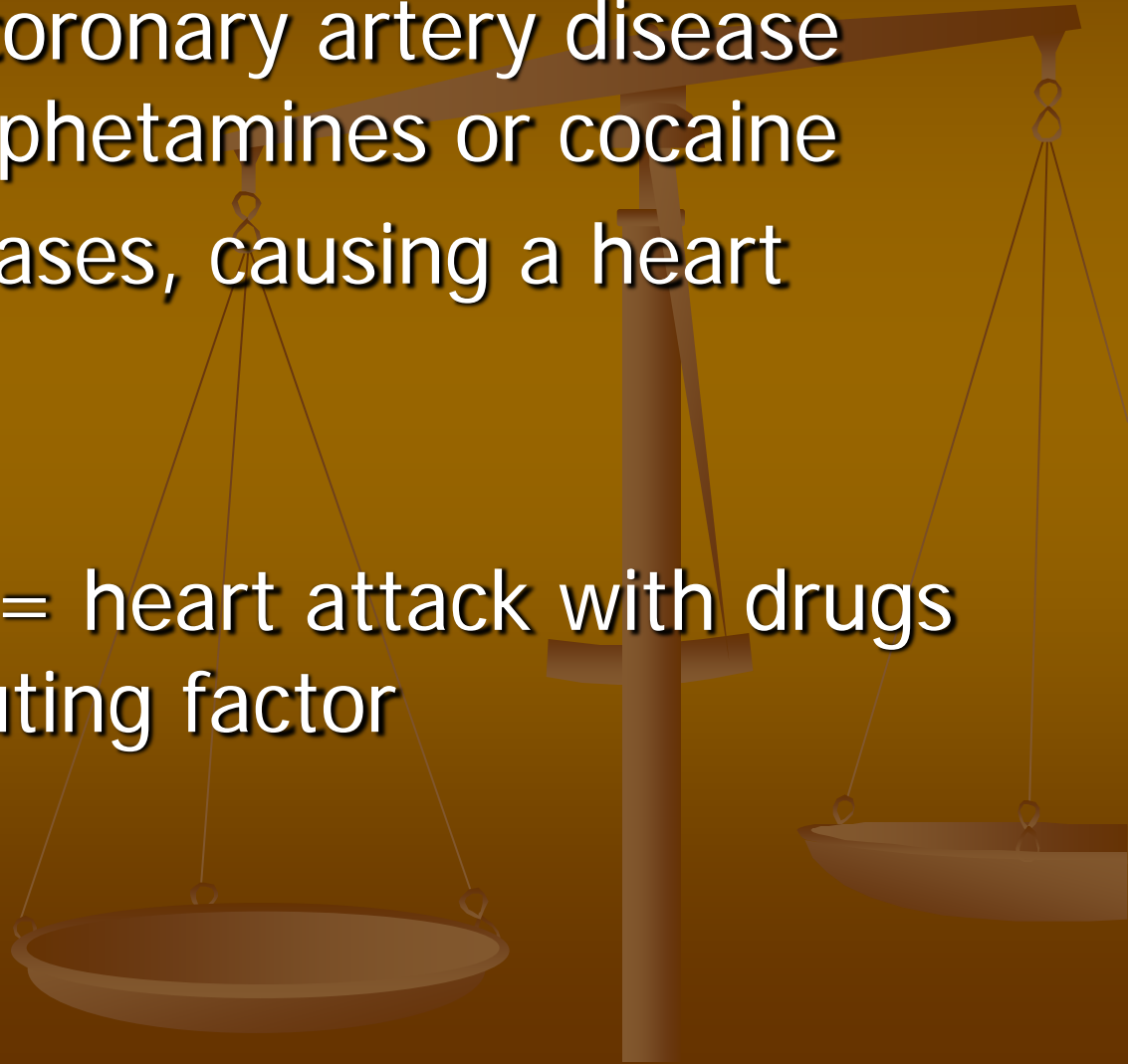
# C.O.D. vs M.O.D.

- Cause of death – what caused the person to die?
  - Heart attack, bullet wound, head trauma, kidney failure, etc.
    - Drugs and poisons are considered "contributing factors"
- Manner of death – how did the person die?
  - Natural cause, accidental, intentional



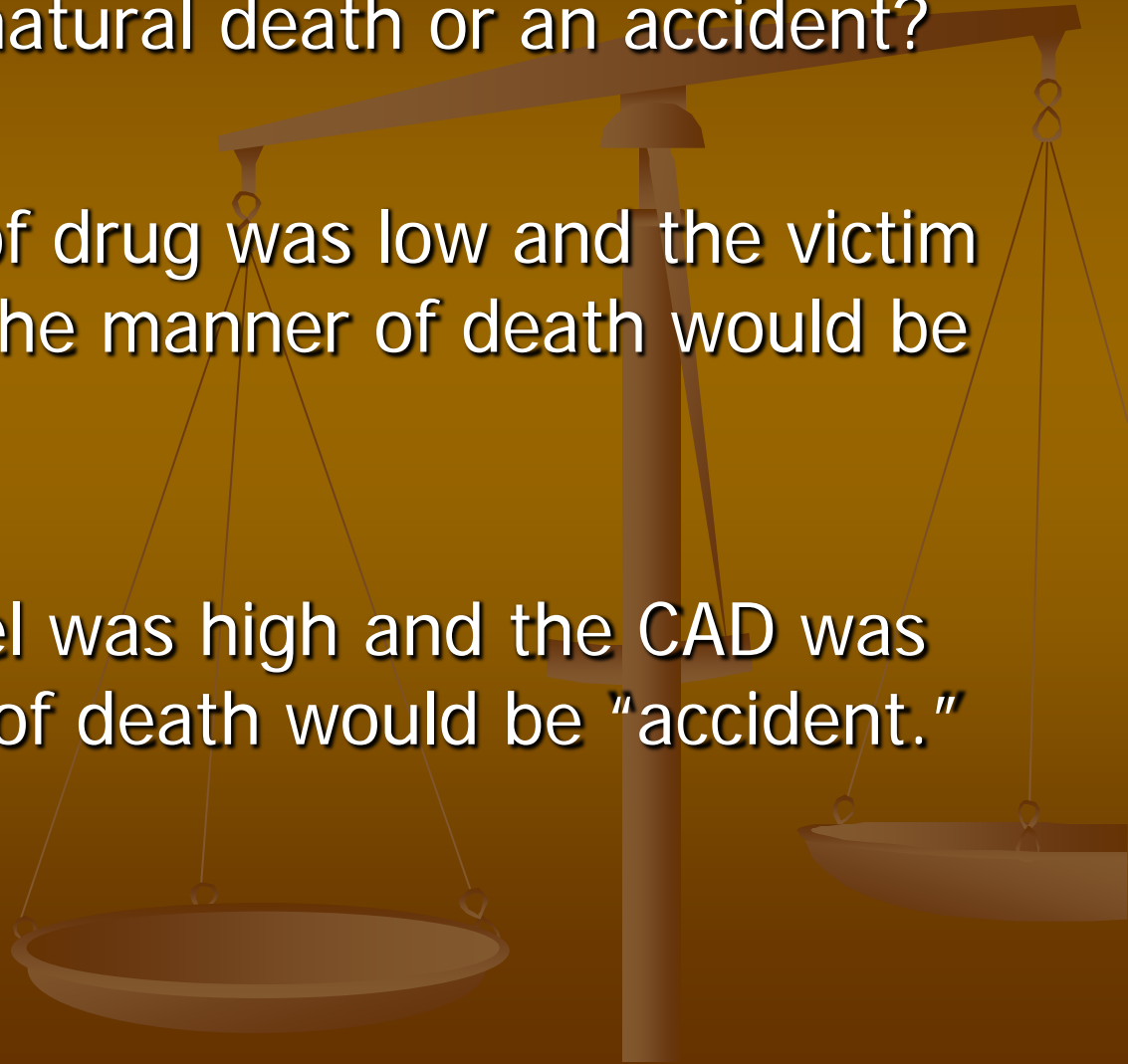
# Cause of death

- Someone with coronary artery disease (CAD) takes amphetamines or cocaine
- Heart rate increases, causing a heart attack
- Cause of death = heart attack with drugs being a contributing factor



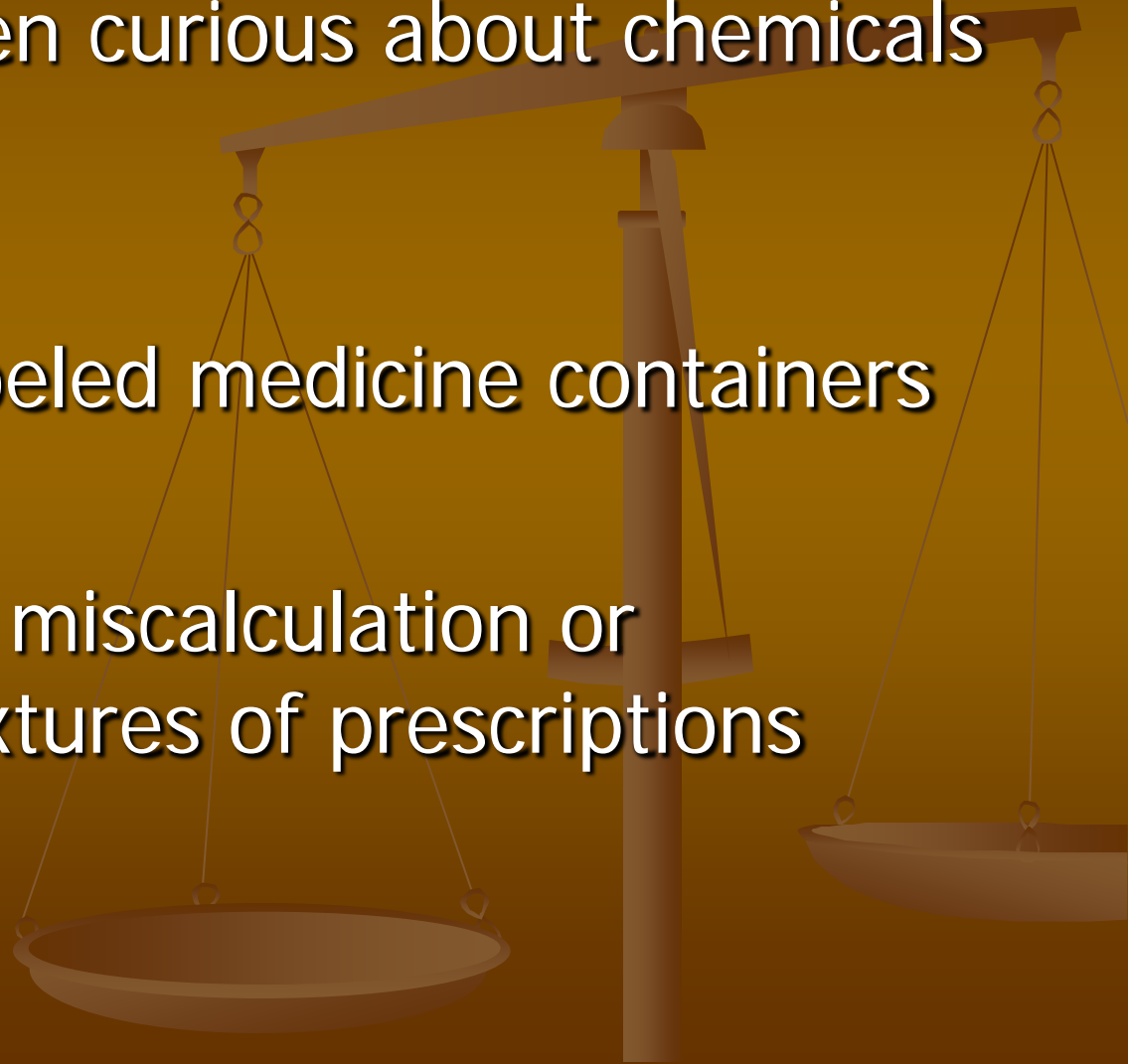
# Manner of Death

- Was the death a natural death or an accident?
- A) if the amount of drug was low and the victim had severe CAD, the manner of death would be "natural"
- B) If the drug level was high and the CAD was mild, the manner of death would be "accident."



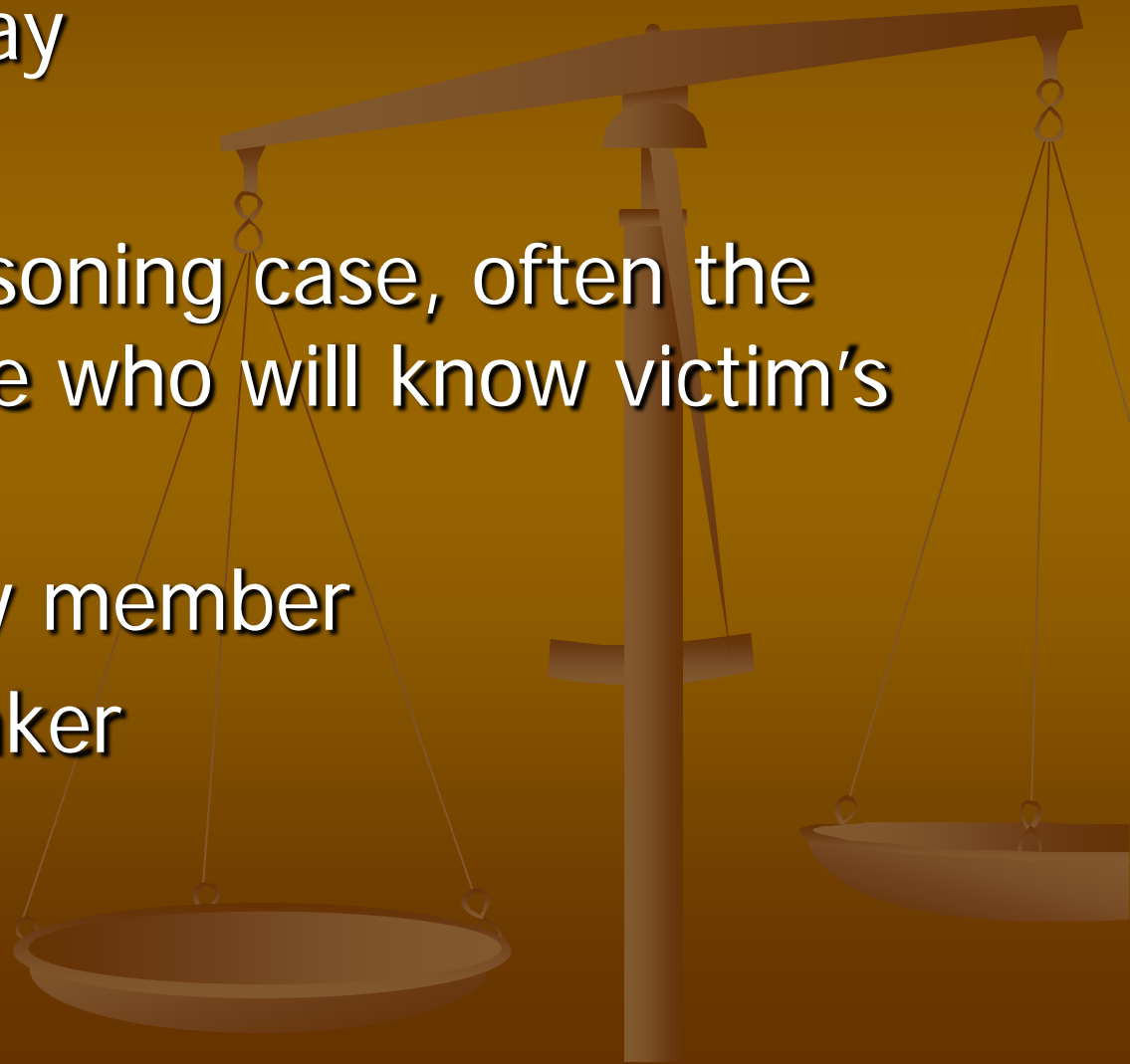
# Common Causes of Accidental Poisoning

- a) Children – often curious about chemicals in the home
- b) Adults – mislabeled medicine containers
- c) Elderly - Dose miscalculation or dangerous mixtures of prescriptions

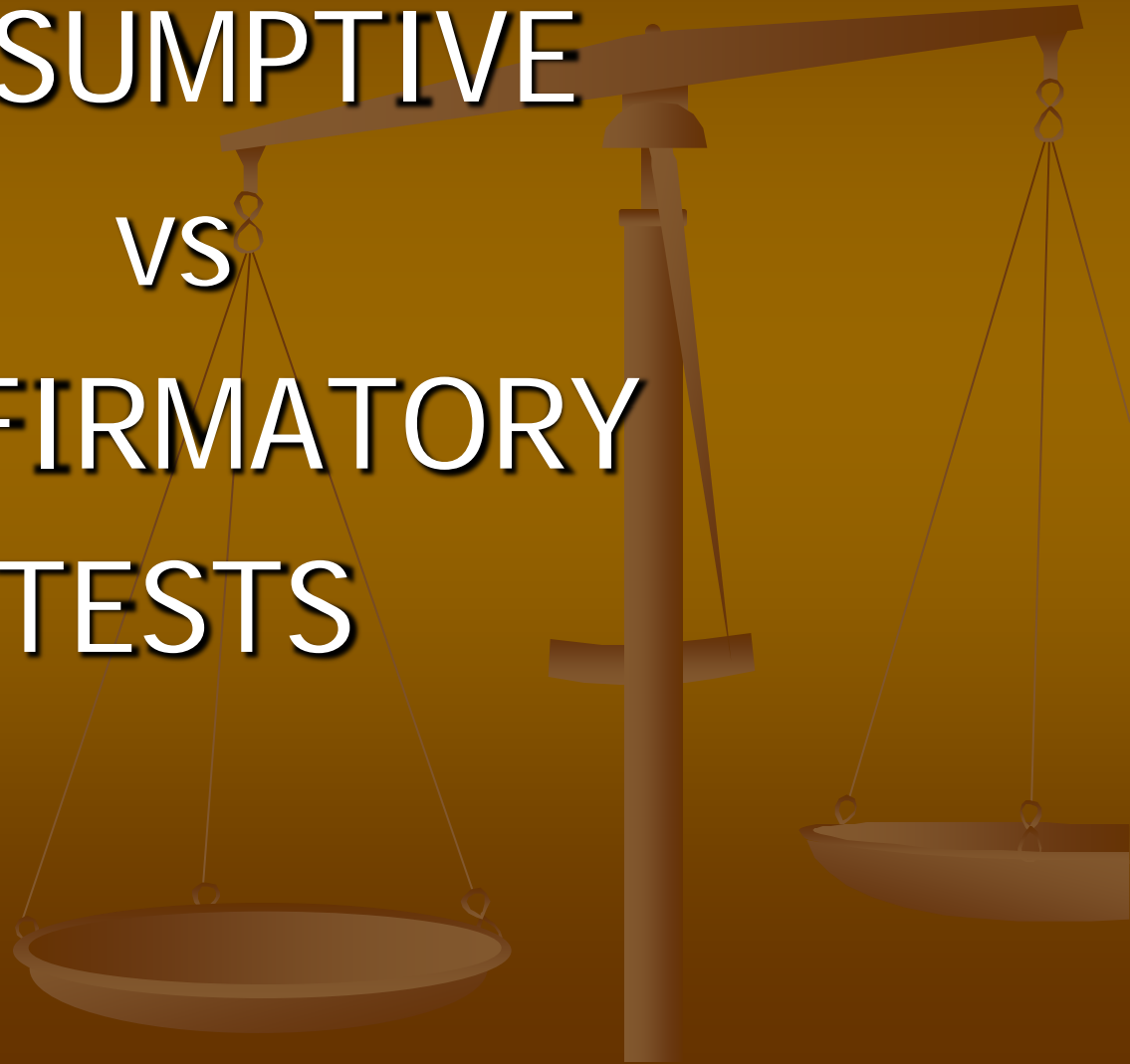


# Homicide by poisoning

- Uncommon today
- If there is a poisoning case, often the killer is someone who will know victim's habits
  - Family member
  - caretaker

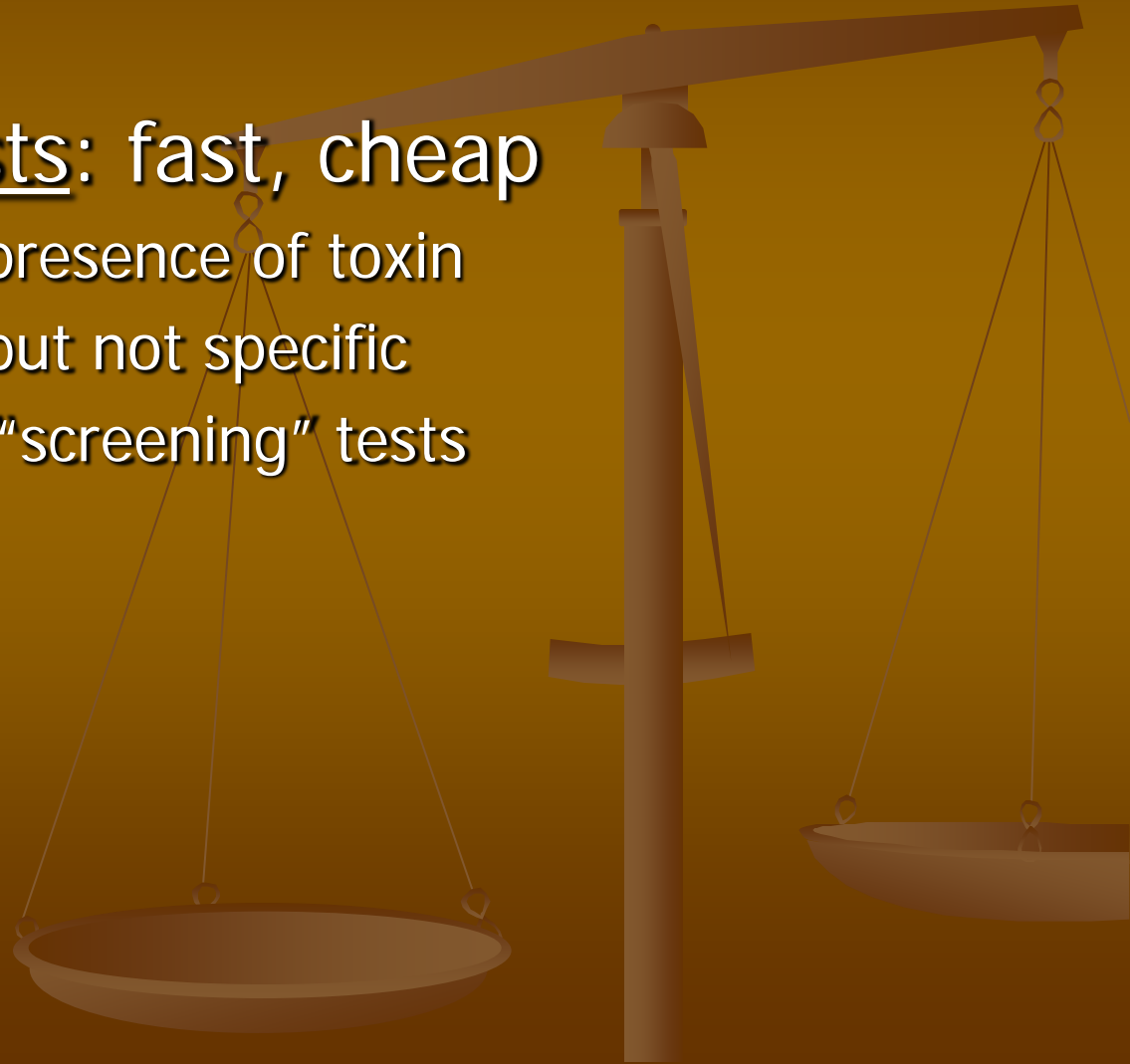


**PRESUMPTIVE  
VS  
CONFIRMATORY  
TESTS**



# Presumptive Tests for Toxins

- Presumptive tests: fast, cheap
  - Indicate likely presence of toxin
  - Very sensitive but not specific
  - Also known as “screening” tests



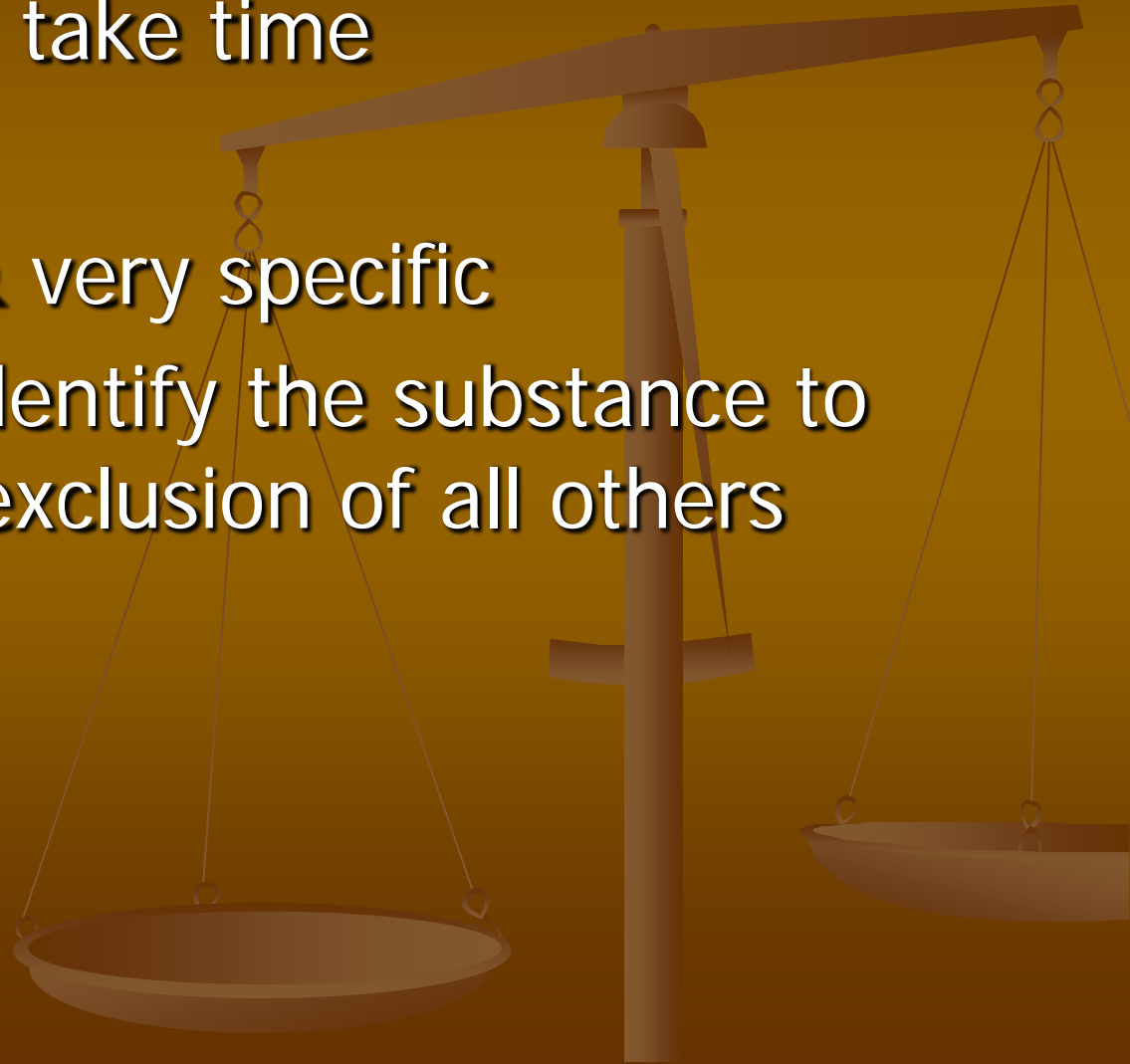


# Confirmatory Tests for Toxins

- \* expensive, take time

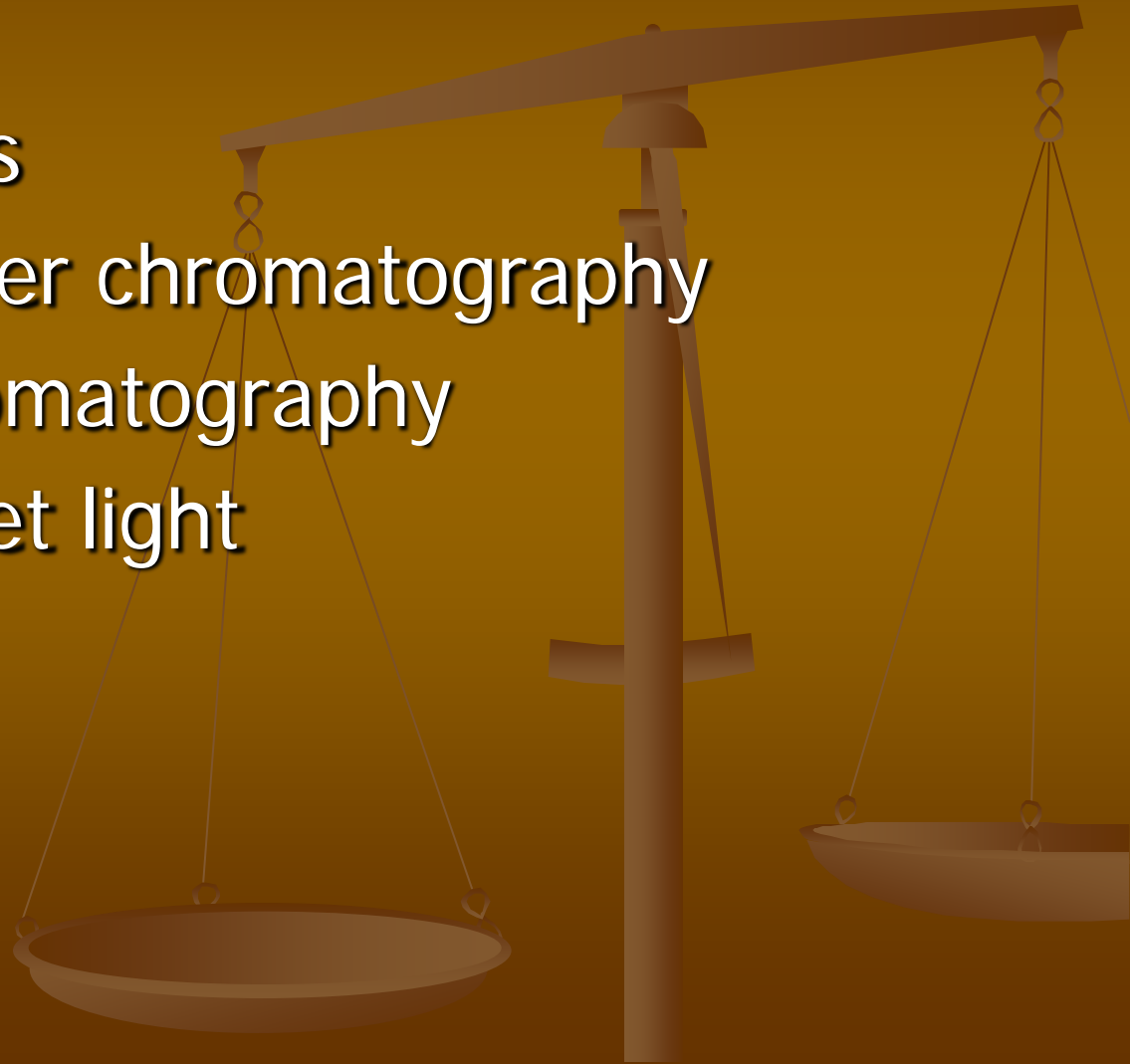
- \* sensitive & very specific

...can identify the substance to  
the exclusion of all others



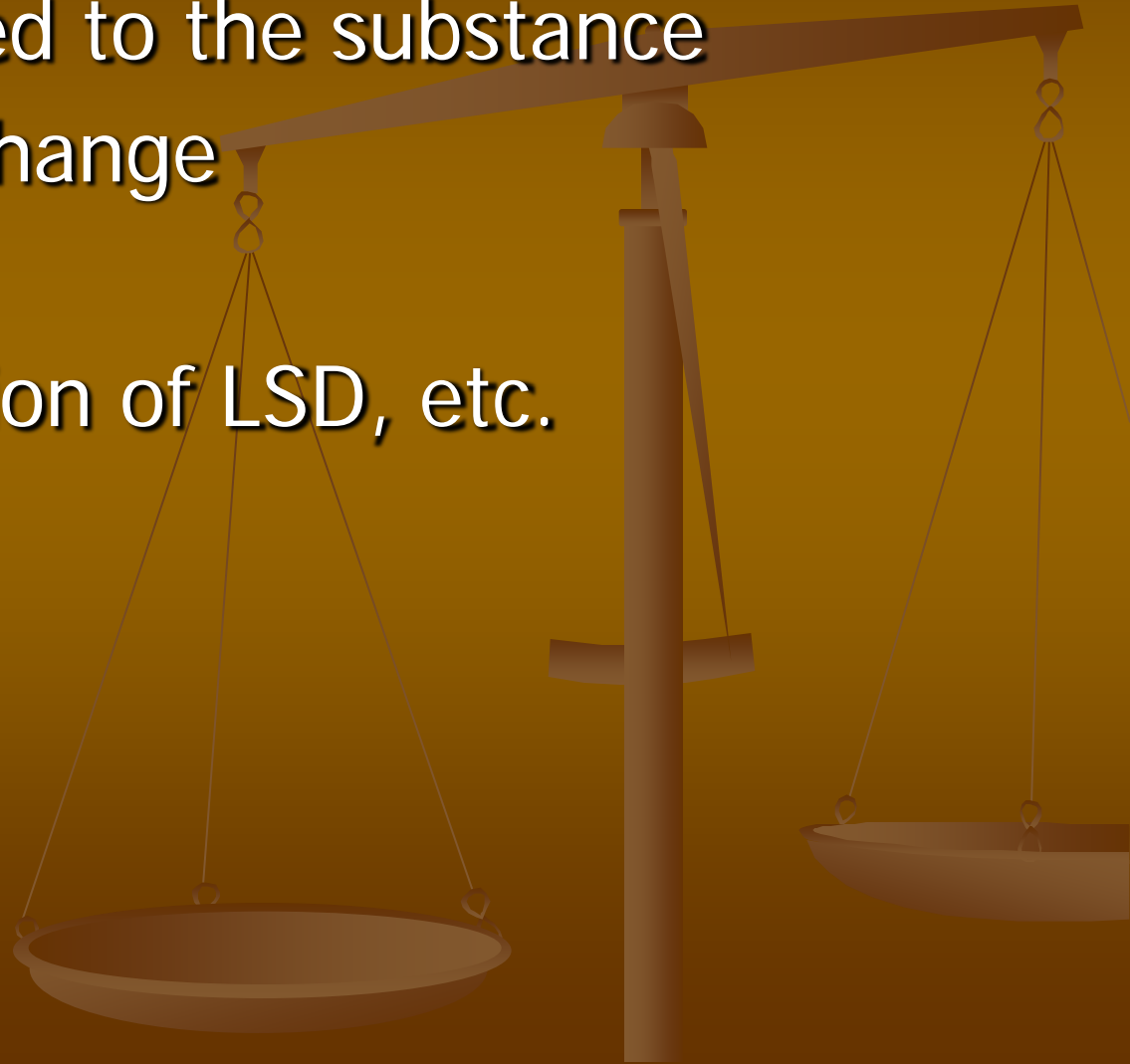
# Presumptive tests

- a) Color tests
- b) Immunoassays
- c) TLC = thin layer chromatography
- d) GC = gas chromatography
- e) UV = ultraviolet light



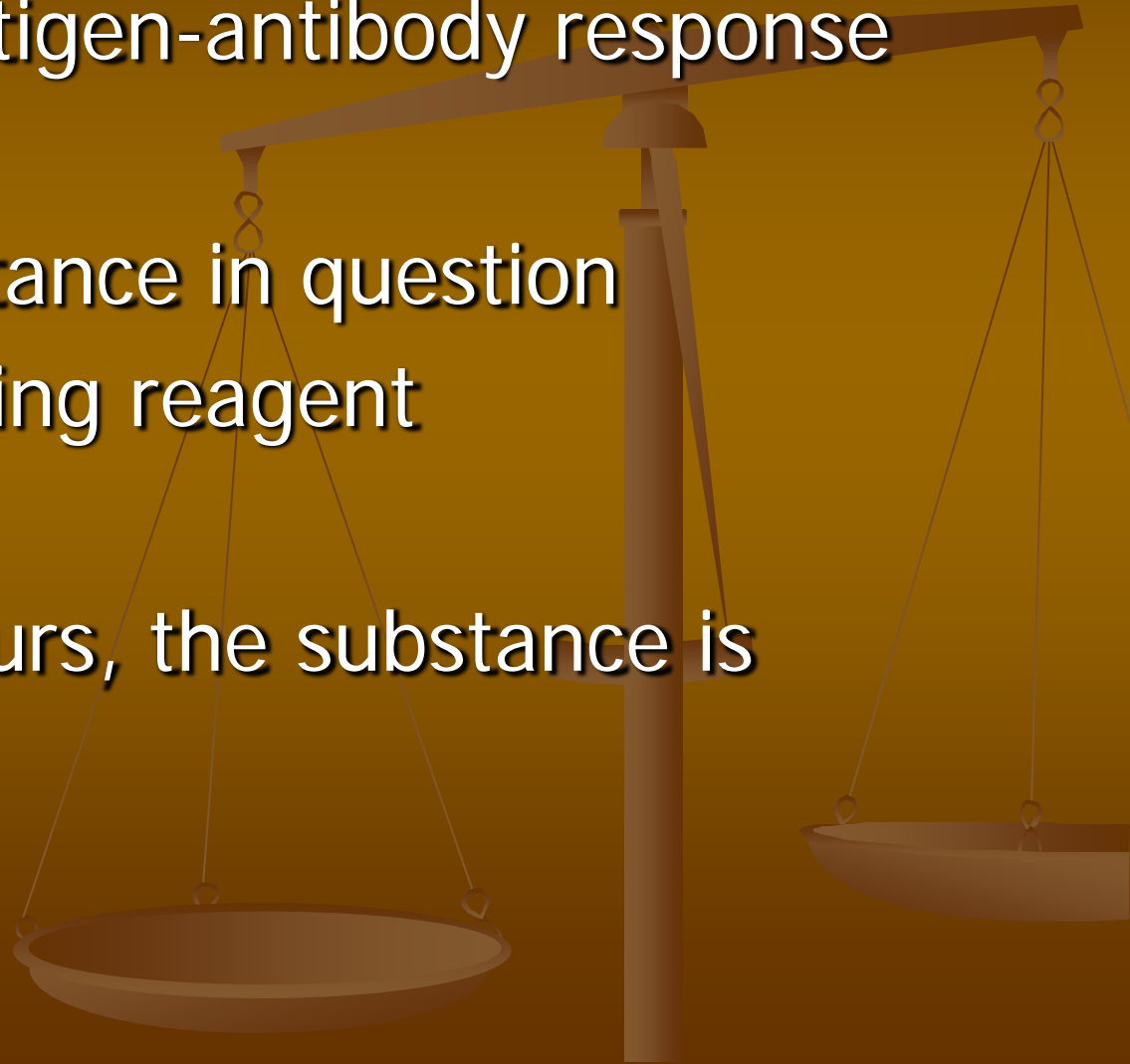
# Color tests

- Reagent is added to the substance
- Look for color change
- Used for detection of LSD, etc.



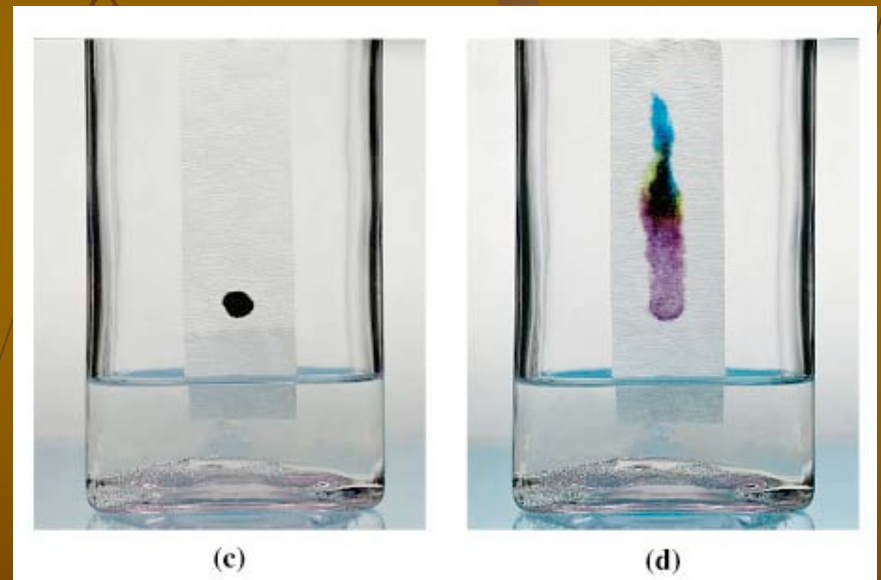
# Immunoassays

- Based on an antigen-antibody response
- Antigen = substance in question
- Antibody = testing reagent
- If clumping occurs, the substance is present



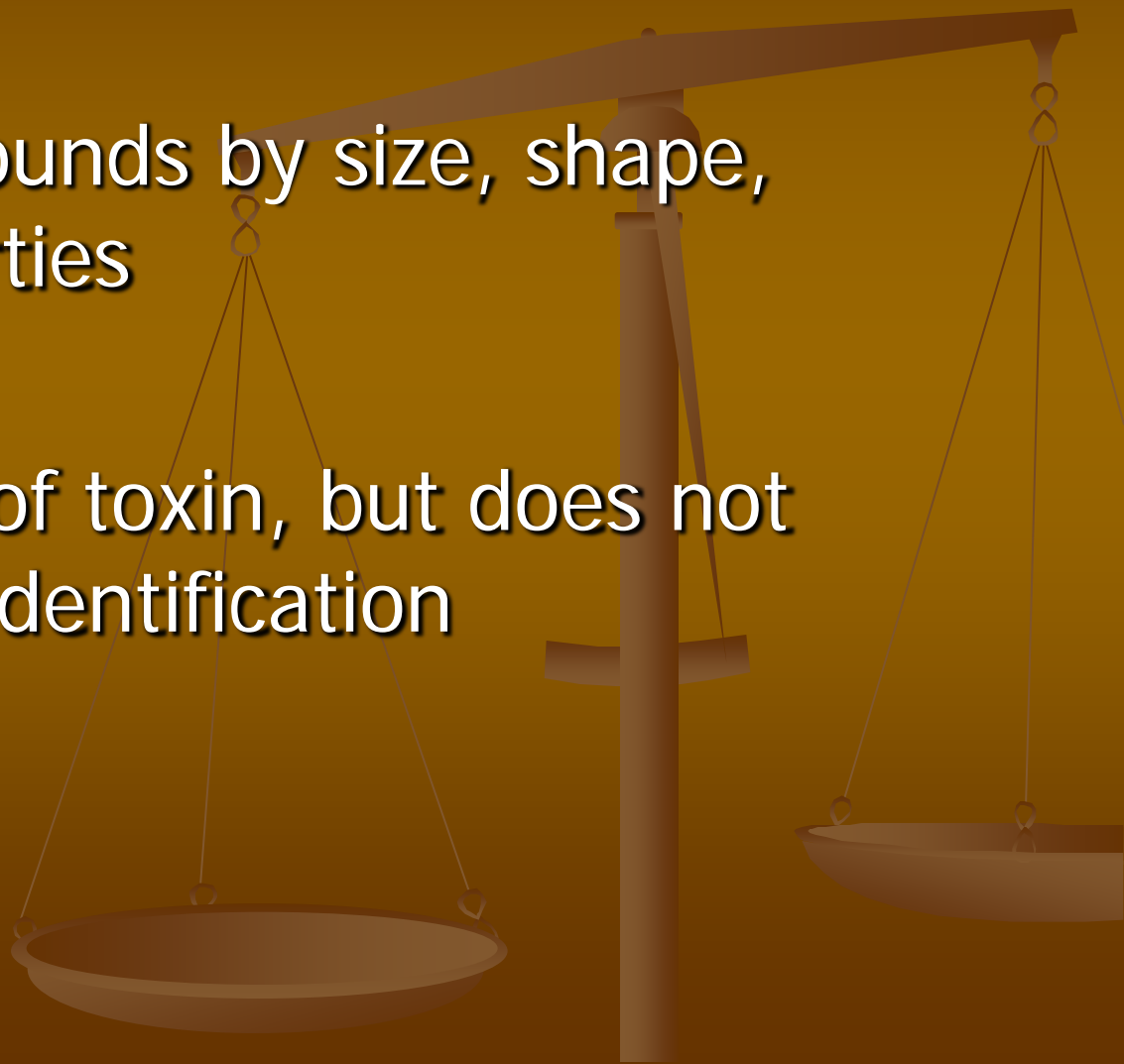
# Thin layer chromatography

- Separate compounds based on how far they move when combined w/ a solvent
- Compare your unknown to known standards



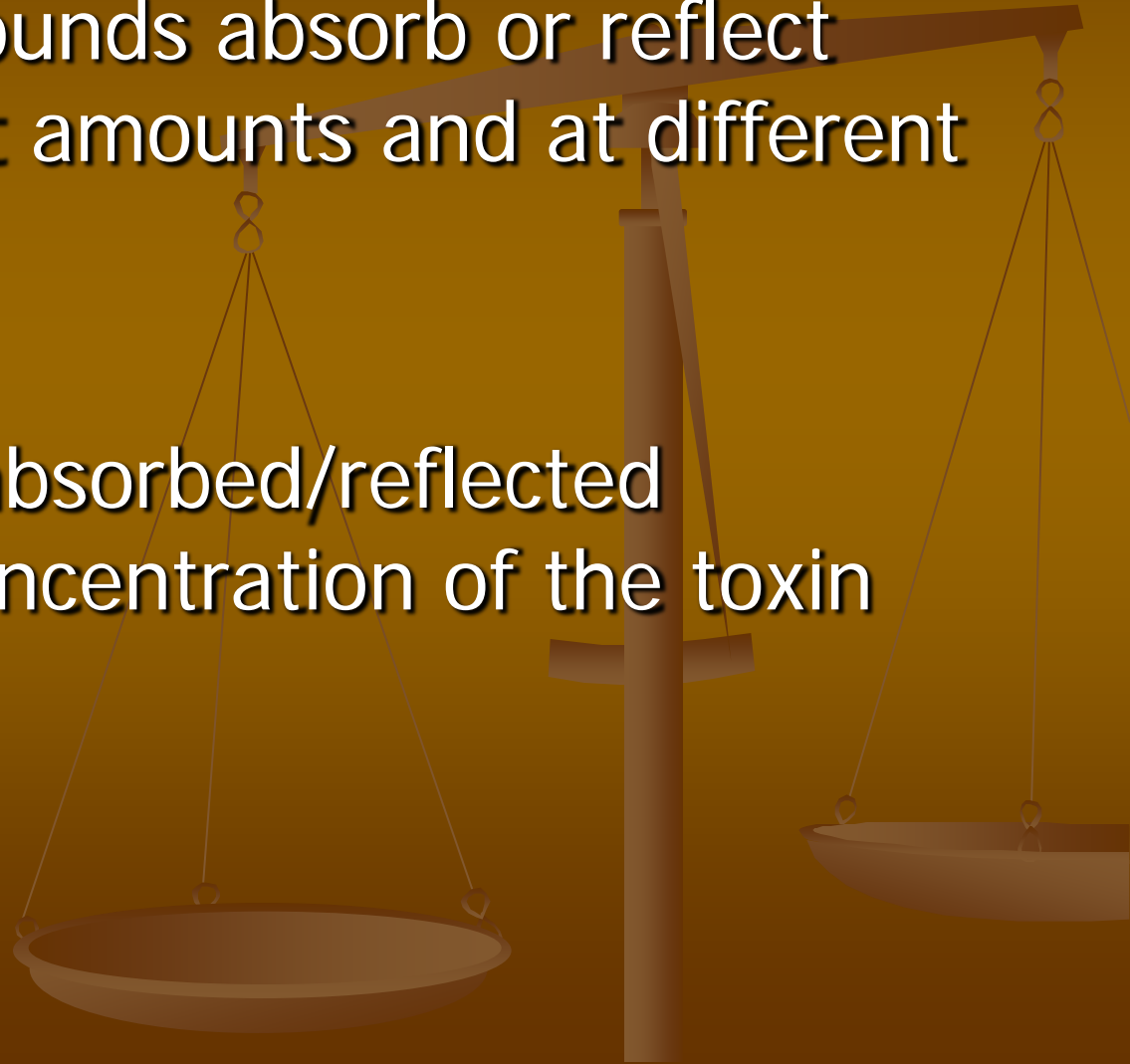
# Gas chromatography

- Separate compounds by size, shape, chemical properties
- Identifies class of toxin, but does not make an exact identification



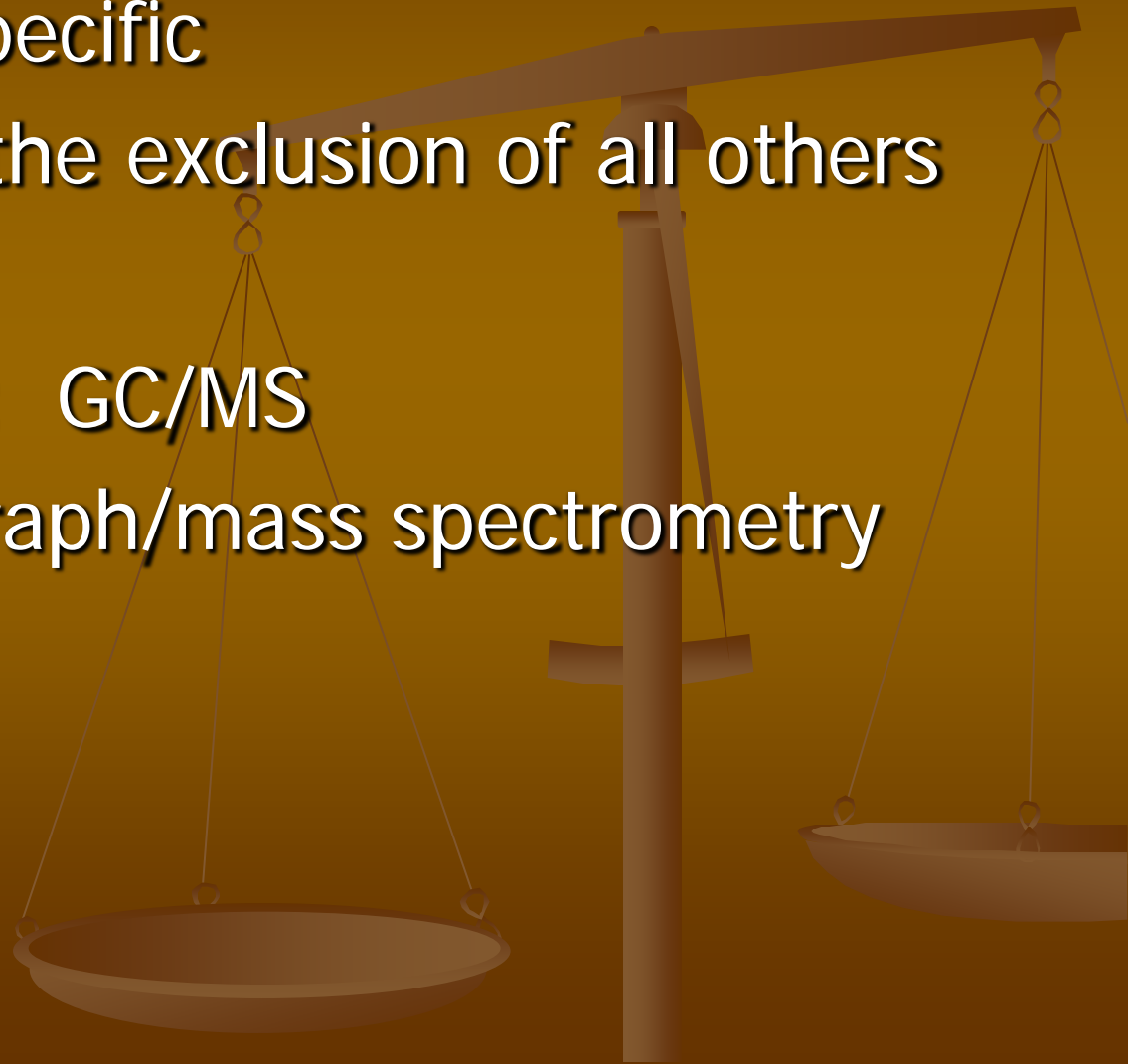
# Ultraviolet light

- Different compounds absorb or reflect light in different amounts and at different wavelengths.
- Extent of light absorbed/reflected indicates the concentration of the toxin



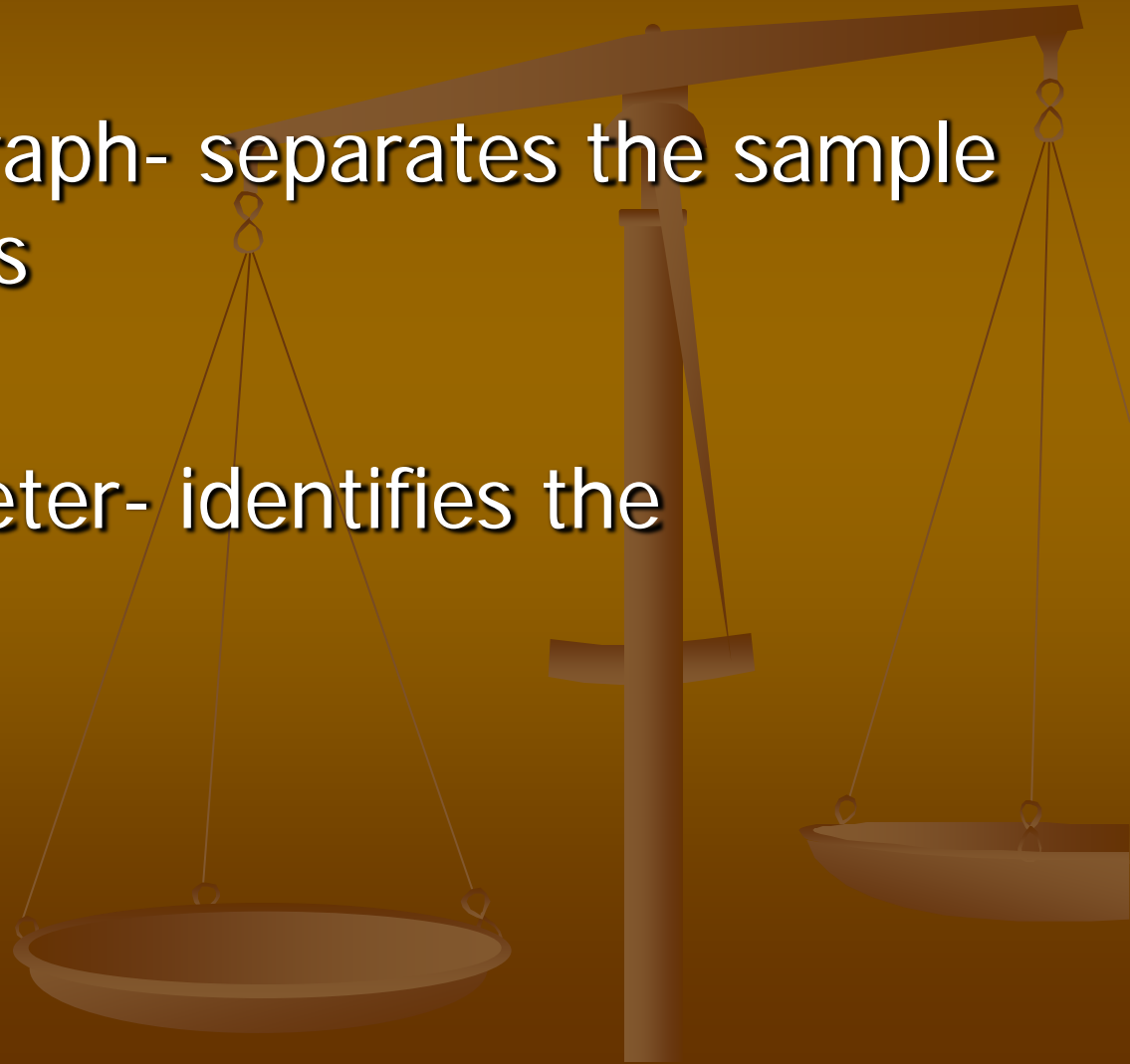
# Confirmatory tests

- Sensitive and specific
- Can identify to the exclusion of all others
- Most important: GC/MS
- Gas chromatograph/mass spectrometry machine



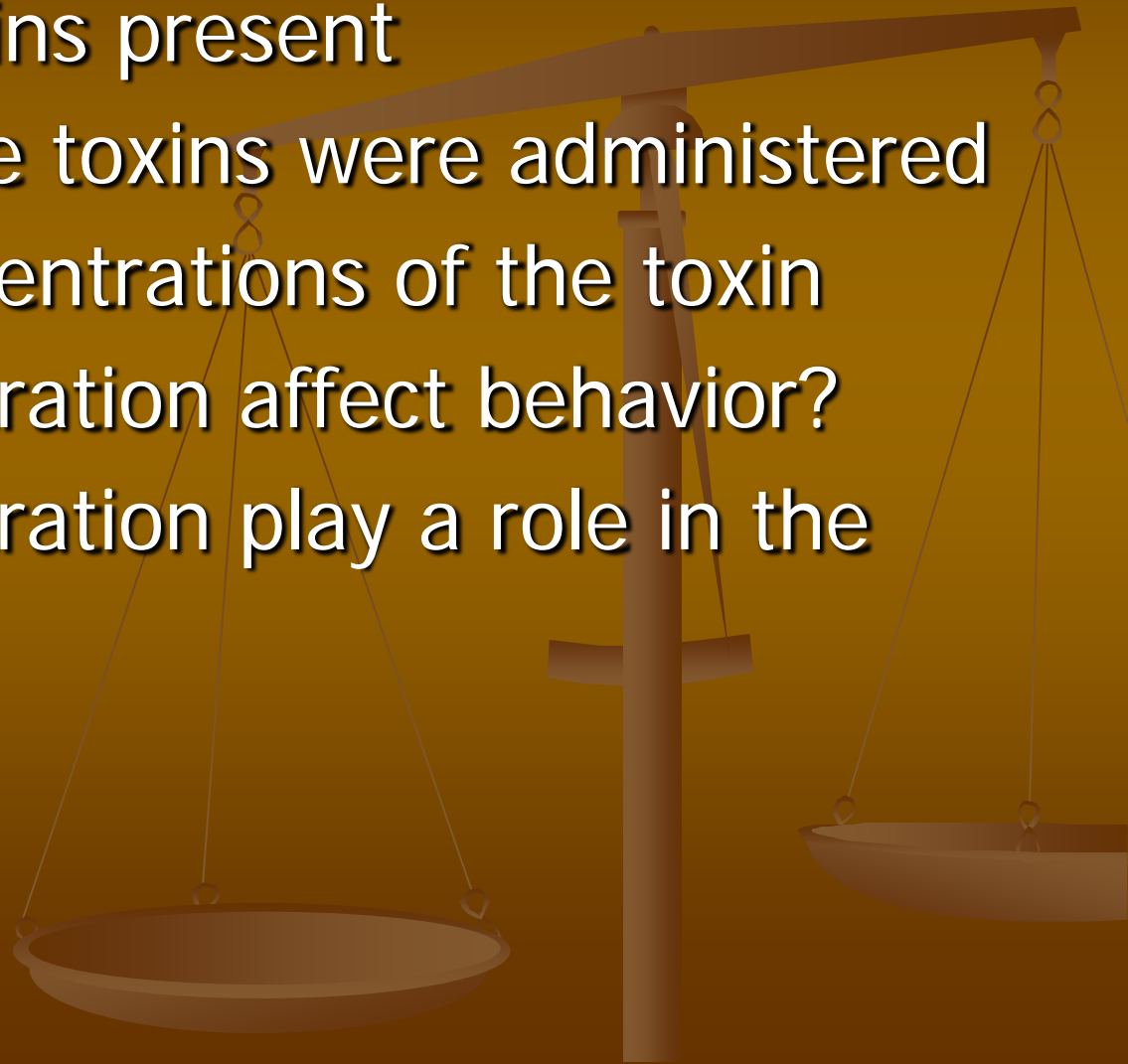


- Gas chromatograph- separates the sample into components
- Mass Spectrometer- identifies the components



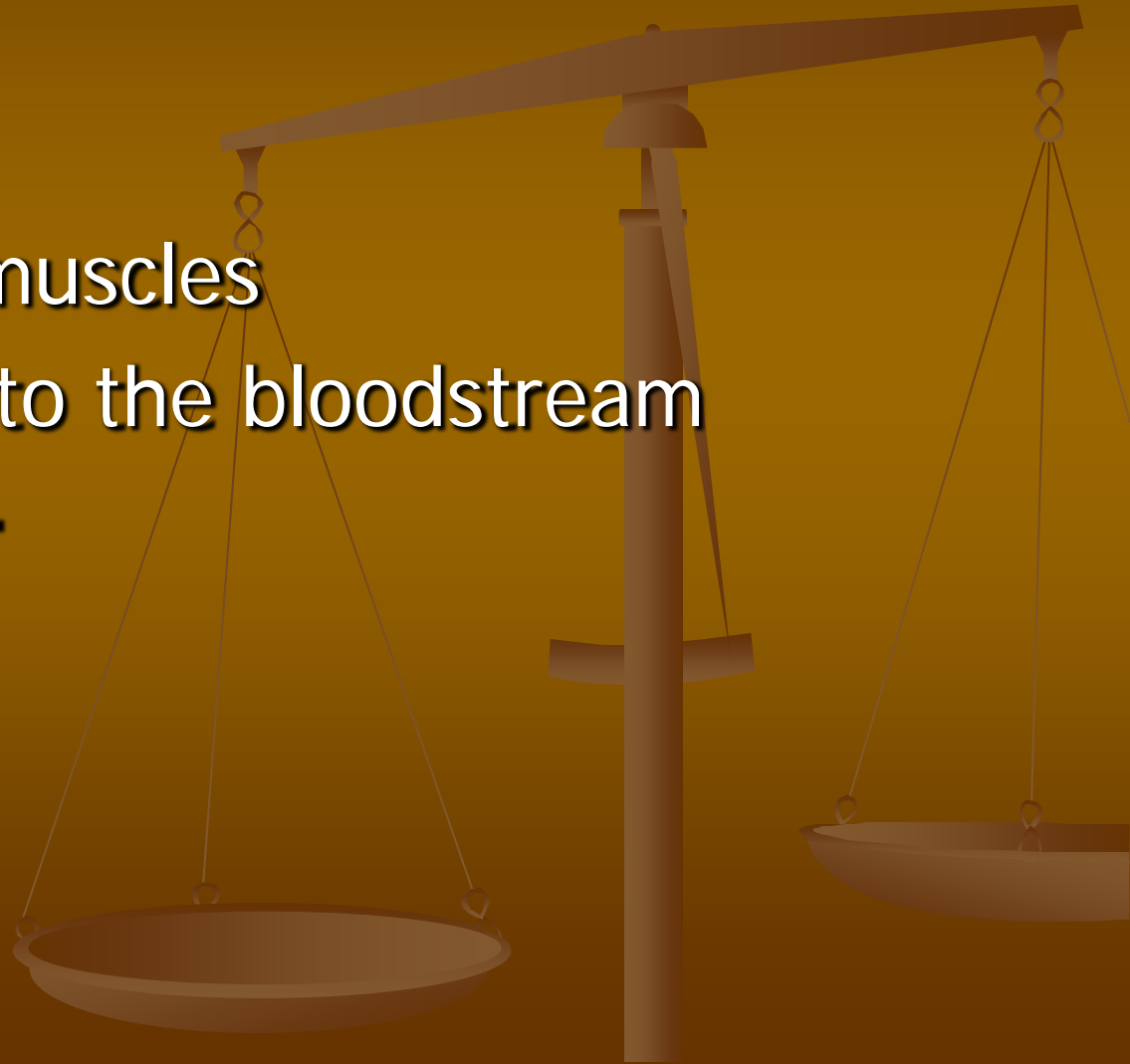
# Interpreting the results of toxicology tests

- Identify the toxins present
- Identify how the toxins were administered
- Determine concentrations of the toxin
- Did the concentration affect behavior?
- Did the concentration play a role in the death?



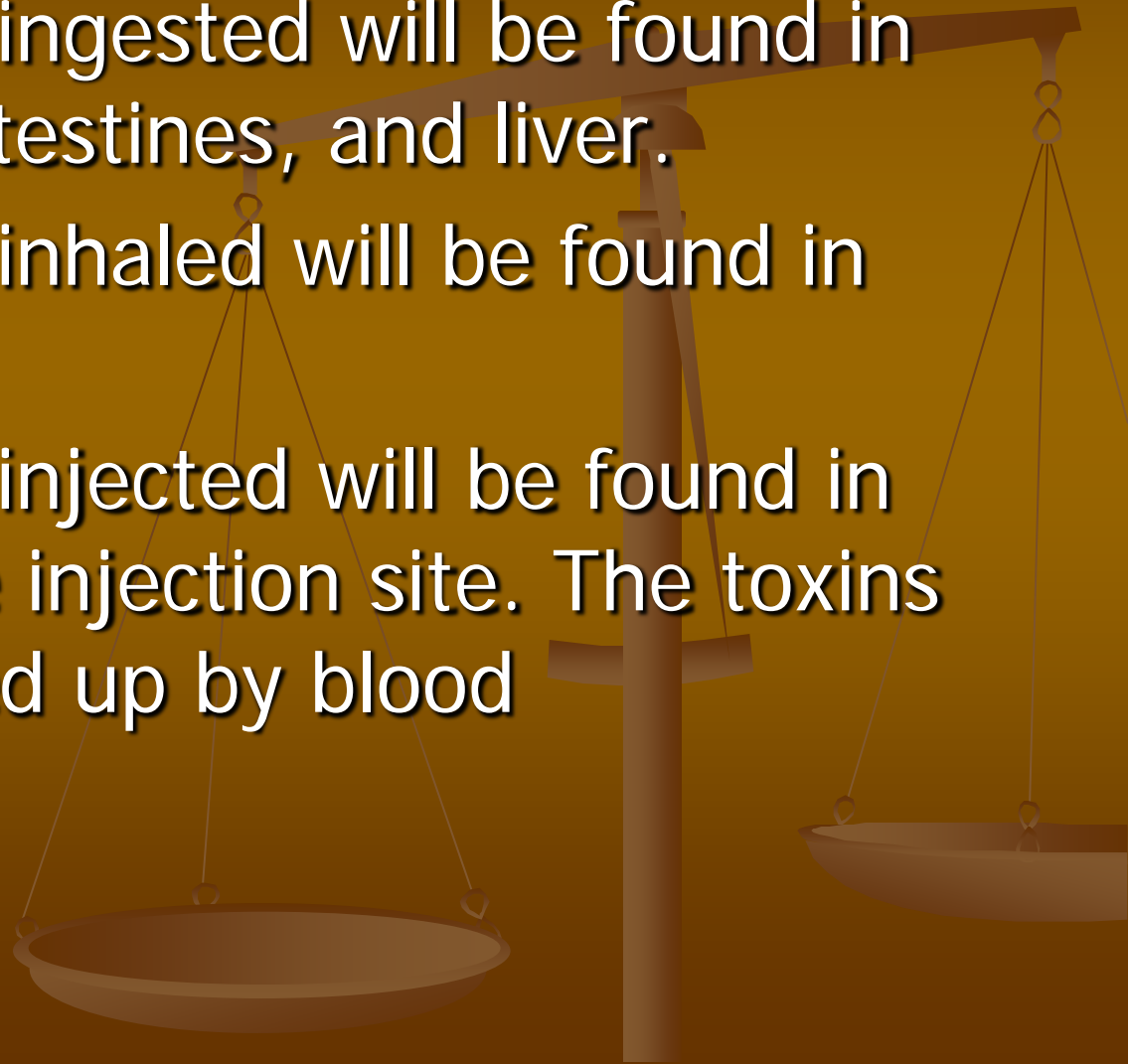
# Toxins can be:

- a) Ingested
- b) Inhaled
- c) Injected into muscles
- d) Put into the into the bloodstream through an IV.

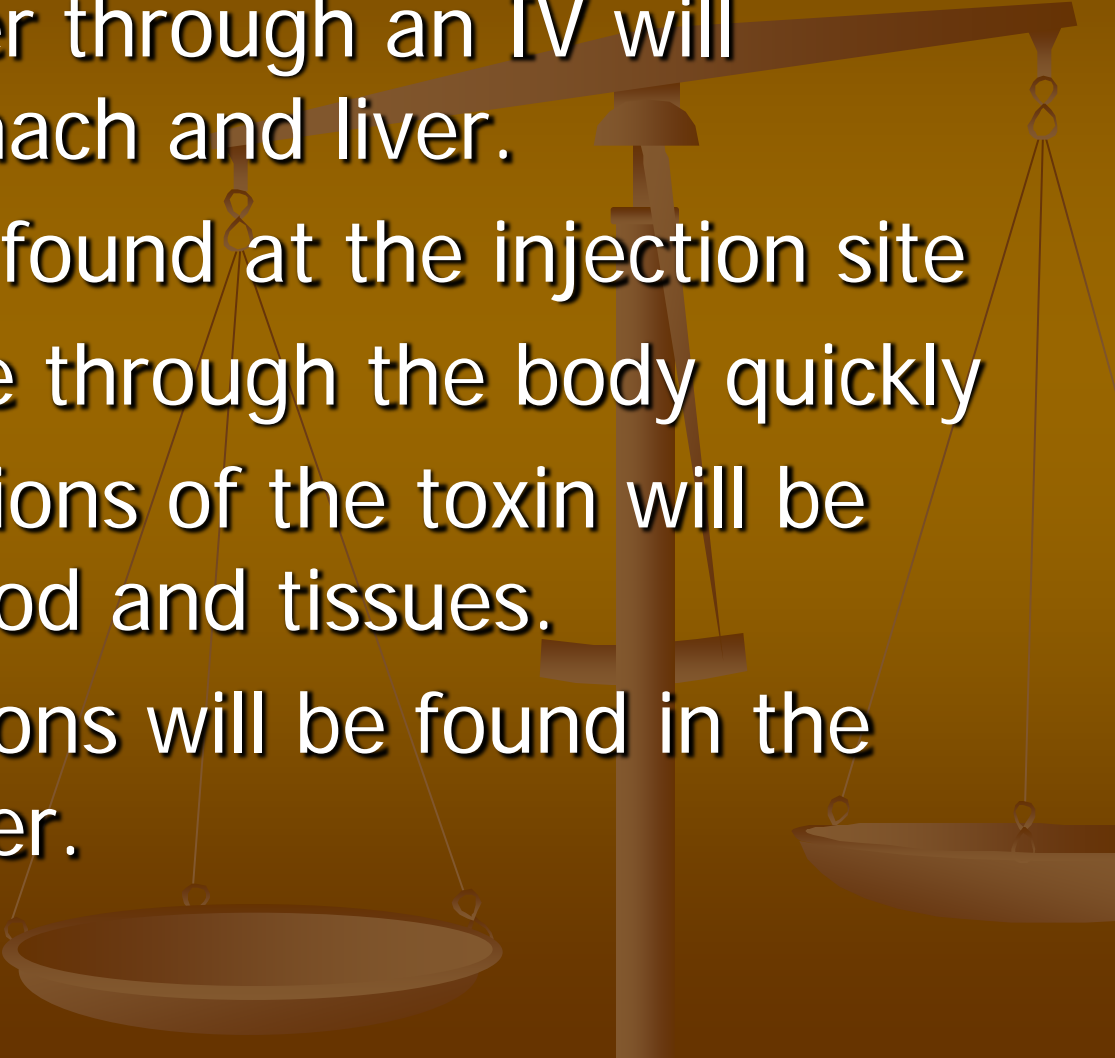


# Ingested

- Toxins that are ingested will be found in the stomach, intestines, and liver.
- Toxins that are inhaled will be found in the lungs
- Toxins that are injected will be found in tissues near the injection site. The toxins are slowly picked up by blood



# IV (intravenous)

- Toxins that enter through an IV will bypass the stomach and liver.
  - No toxin will be found at the injection site
  - Toxins will move through the body quickly
  - High concentrations of the toxin will be found in the blood and tissues.
  - Low concentrations will be found in the stomach and liver.
- 

# Toxicity affected by

- Age
- Sex
- Body size/weight
- Genetics
- Nutrition
- Overall Health



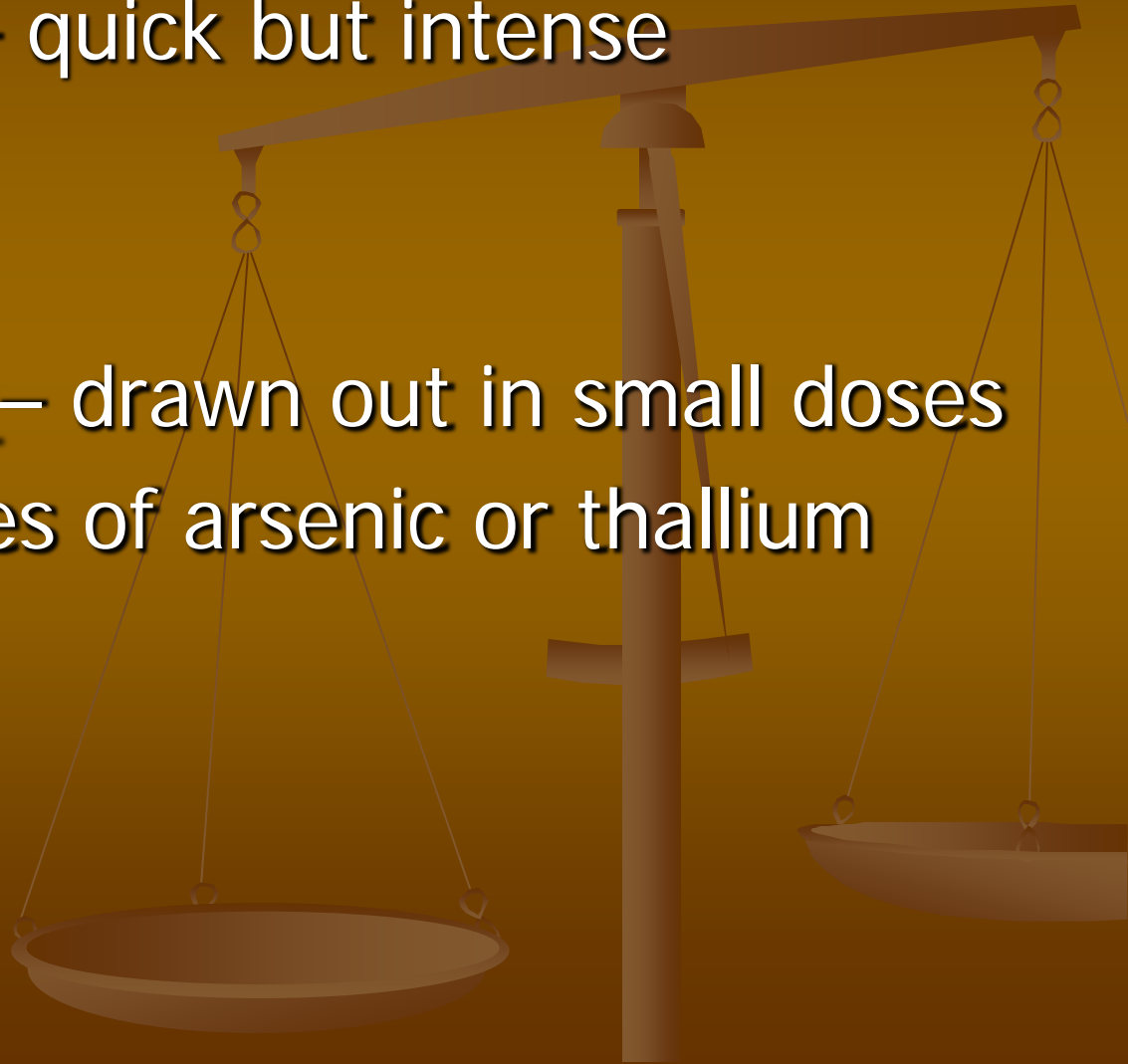
# Acute versus chronic

Acute poisoning – quick but intense

Ex. cyanide

Chronic poisoning– drawn out in small doses

Ex. Low doses of arsenic or thallium



# Hair

- Reveals exposure to toxin
- Reveals timeline
- Hair grows  $\frac{1}{2}$  inch per month
- Robert Curley
- [Drug Analysis Laboratories.doc](#)



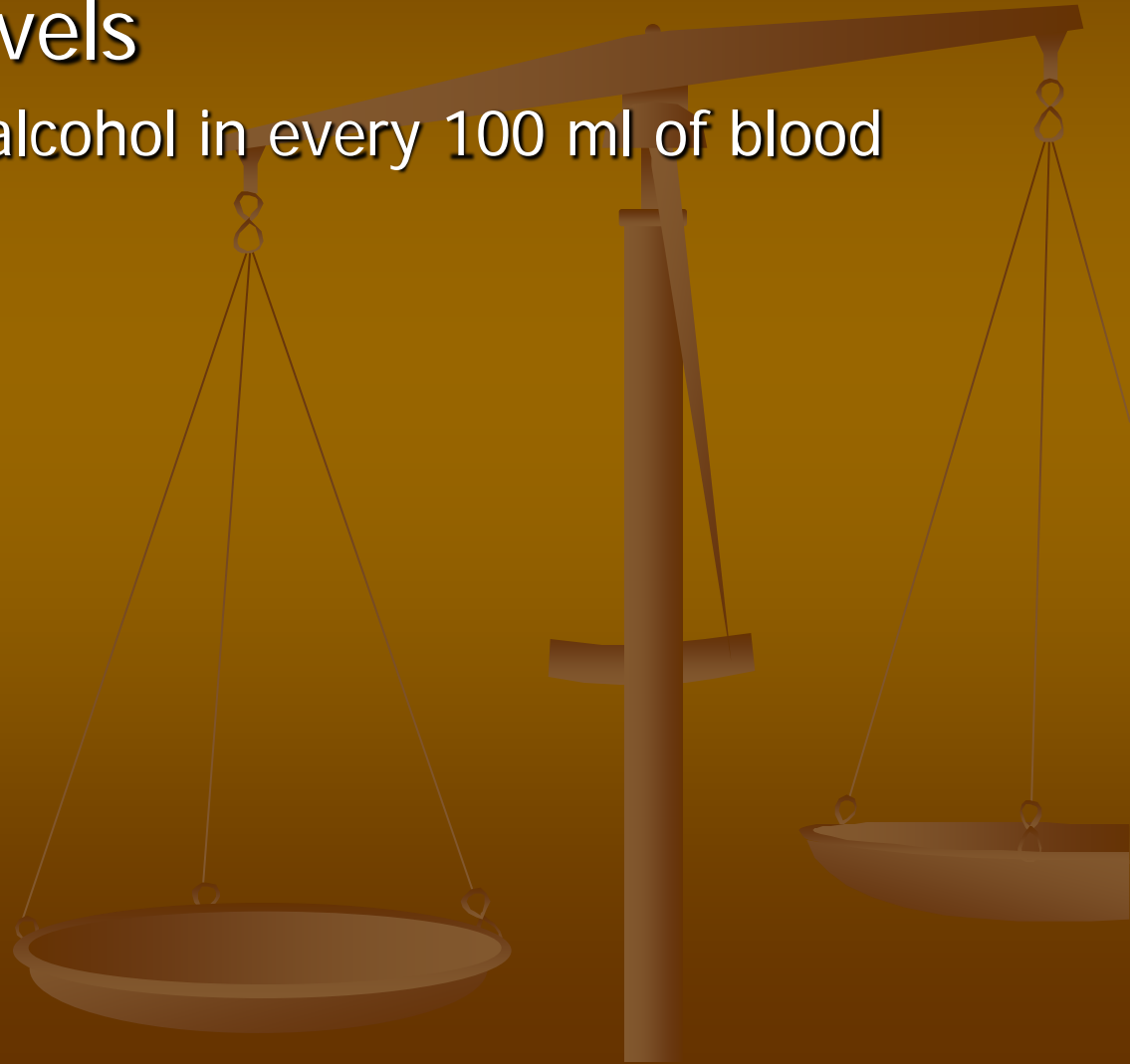


# Alcohol

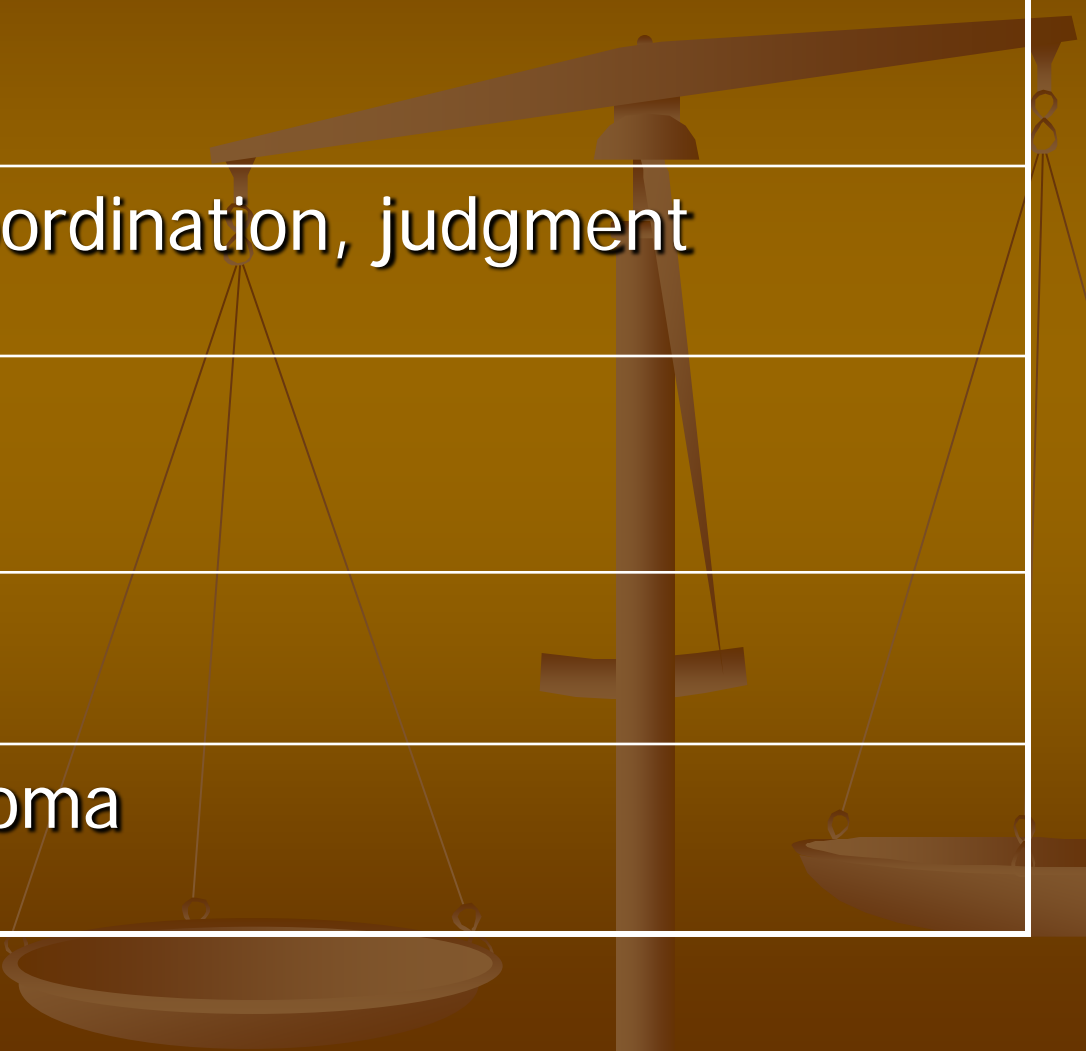
- Blood alcohol levels

- # of grams of alcohol in every 100 ml of blood

.08 – legal limit



# Blood alcohol levels



0.03	OK
0.03-0.08	Lose coordination, judgment
0.12	vomit
0.25	Coma
0.30	Deep coma

# Evaluation

a) Field sobriety test

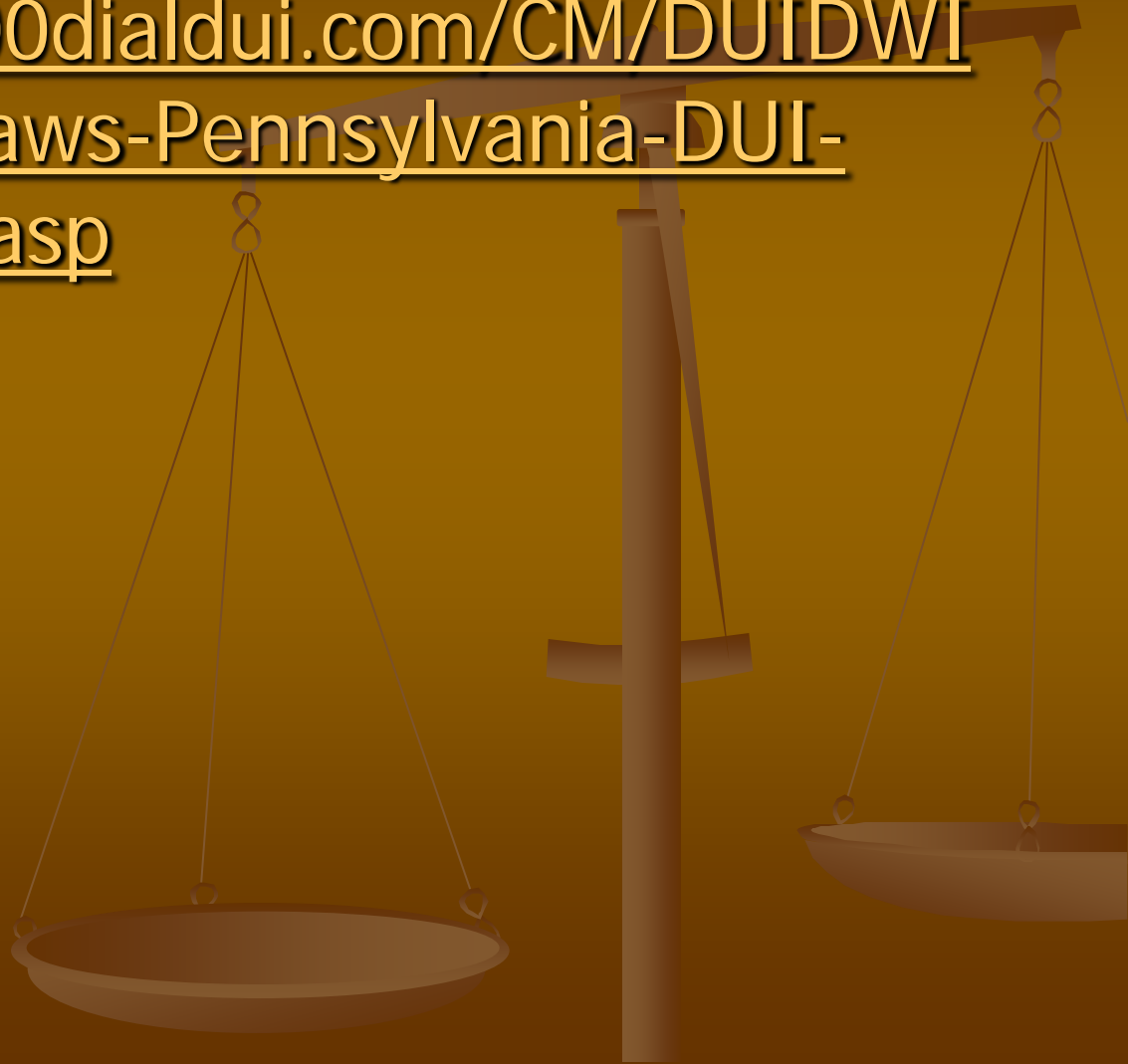
b) Breathalyzer

a) Blood test



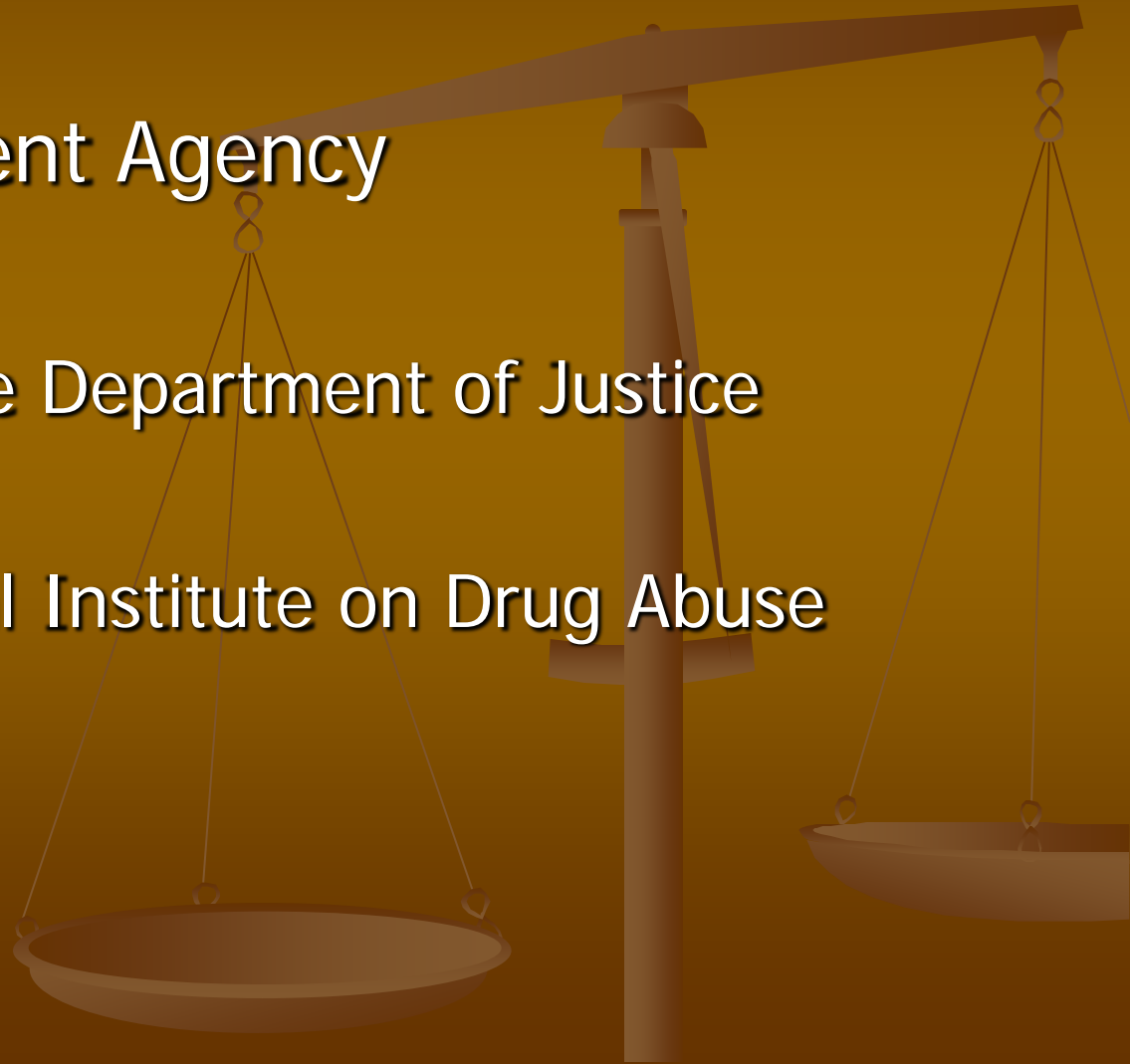
# Pennsylvania DUI Laws

- <http://www.1800dialdui.com/CM/DUIDWI/Laws/DUIDWILaws-Pennsylvania-DUI-Laws-Penalties.asp>



# DEA

- Drug Enforcement Agency
  - A division of the Department of Justice
  - NIDA – National Institute on Drug Abuse



# DRUG STATISTICS:

- <http://www.usdoj.gov/dea/statistics.html#arrests>



# Drug Charges



- Supply charges depend critically on the quantity and quality of the drug found.
- Example:
- In one typical case involving herbal cannabis, the charge related to possession of about a kilo of the stuff which it was alleged was intended for supply, and likely to command a price of at least £3,000.
  - A detailed examination of the material showed that the cannabis was mainly leaf with little or no evidence of flowering tops - where the vast majority of the active ingredients of cannabis reside. It was therefore debatable whether the material had any realistic sale value at all. This was accepted by the prosecution's scientist and the charge of supply, dropped.

# Drug Penalties

- <http://www.pennsylvania-criminal-defense.com/drugpossession.htm>

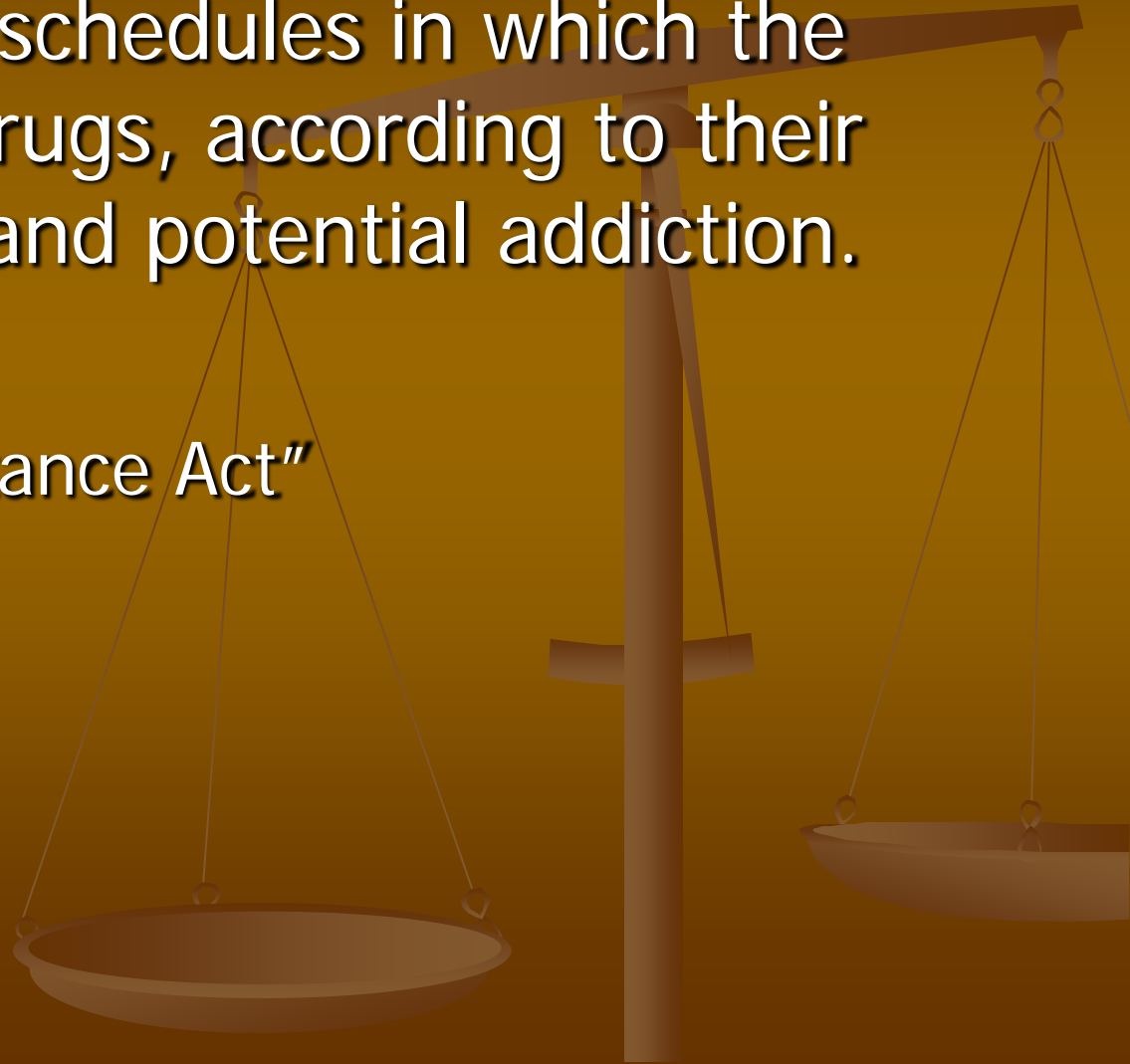




# Drugs are “scheduled”

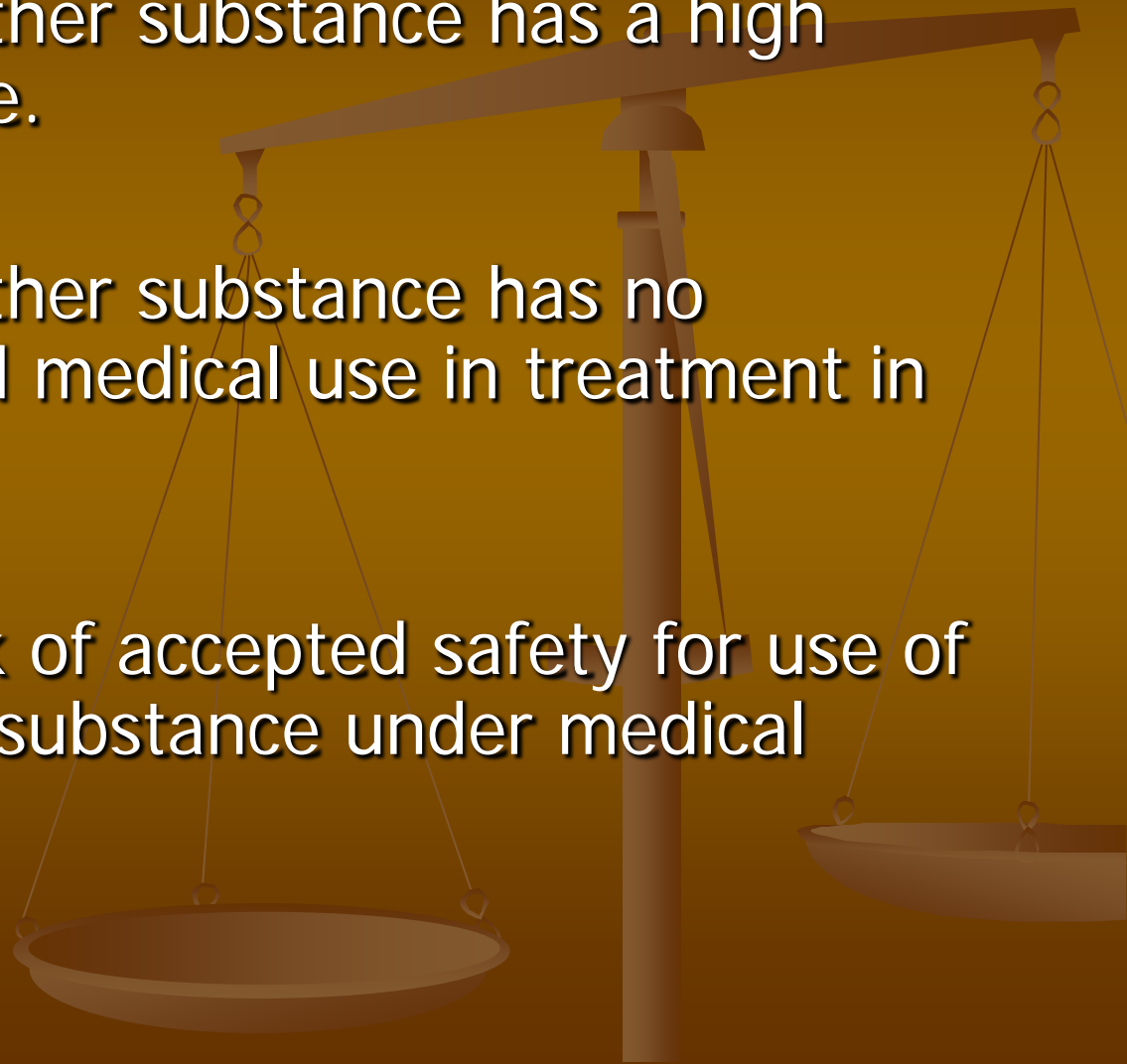
- There are FIVE schedules in which the DEA classifies drugs, according to their medicinal uses and potential addiction.

“Controlled Substance Act”



# Schedule I. -

- (A) The drug or other substance has a high potential for abuse.
- (B) The drug or other substance has no currently accepted medical use in treatment in the United States.
- (C) There is a lack of accepted safety for use of the drug or other substance under medical supervision.



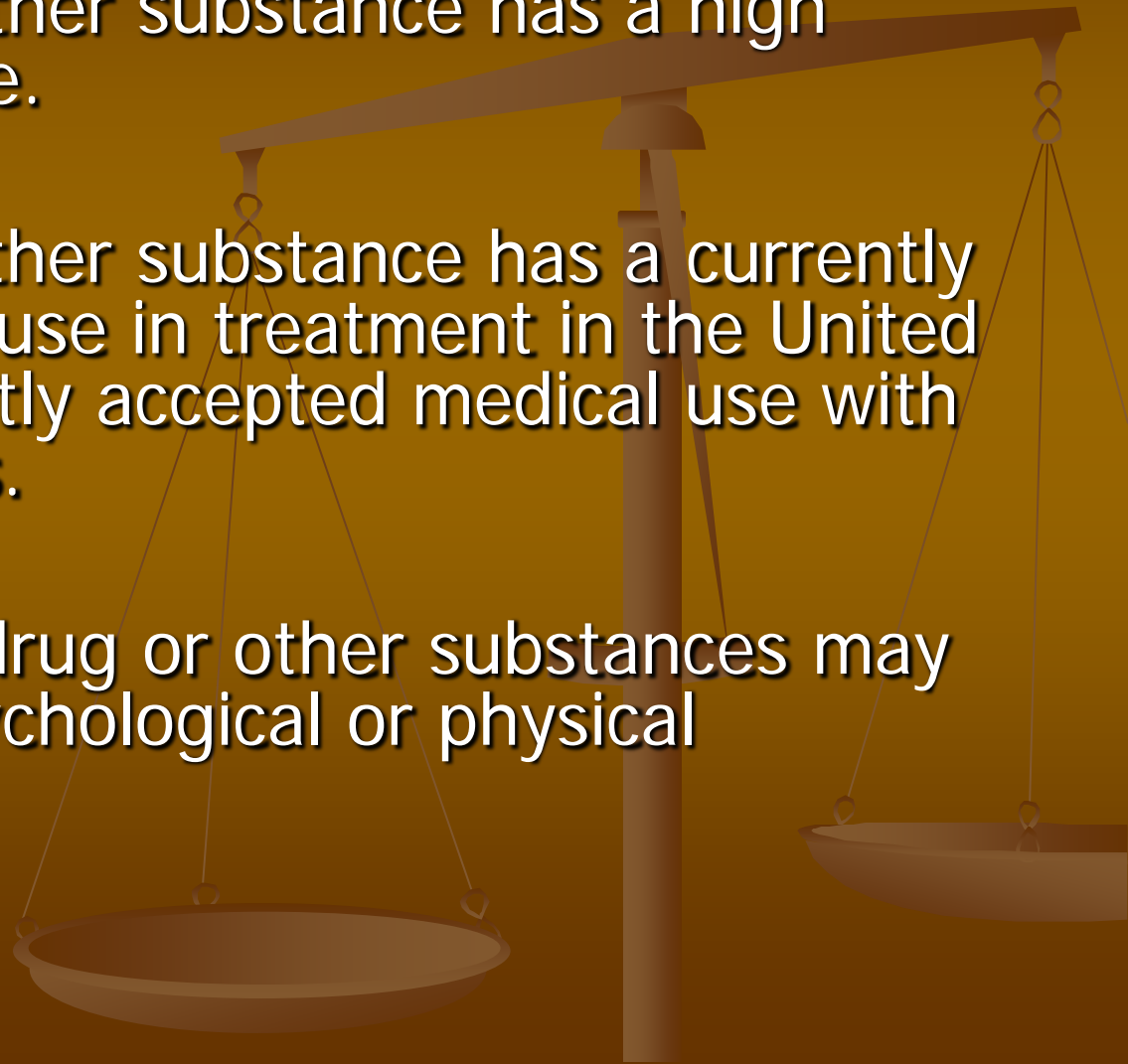
# Examples of Schedule I drugs:

- Heroin
- Marijuana
- Peyote
- Mescaline
- Lysergic acid diethylamide (LSD)



# Schedule II. -

- (A) The drug or other substance has a high potential for abuse.
- (B) The drug or other substance has a currently accepted medical use in treatment in the United States or a currently accepted medical use with severe restrictions.
- (C) Abuse of the drug or other substances may lead to severe psychological or physical dependence.



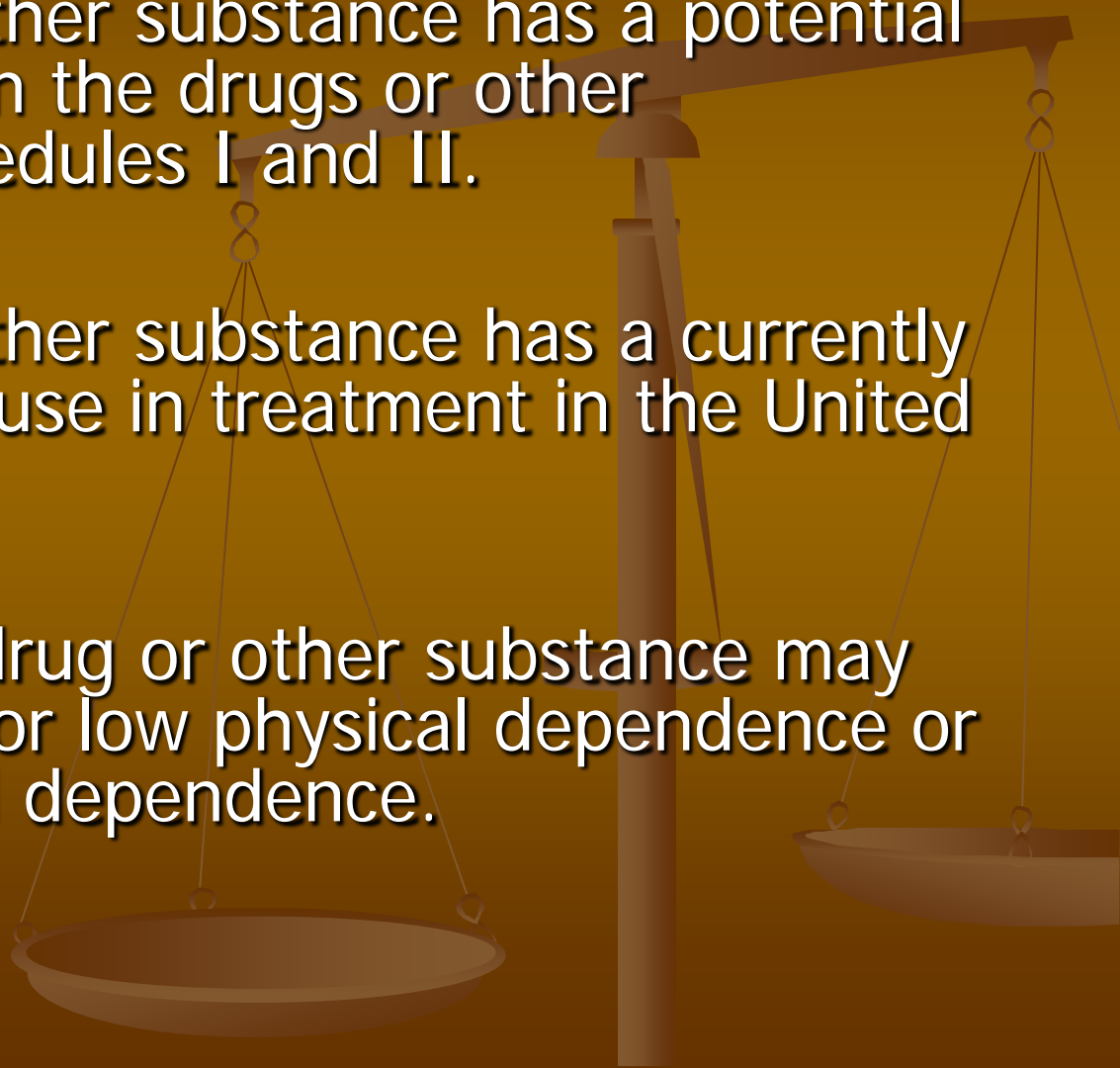
# Examples of Schedule II drugs:

- Opium
- Cocaine
- Methadone
- Injectable liquid Methamphetamines



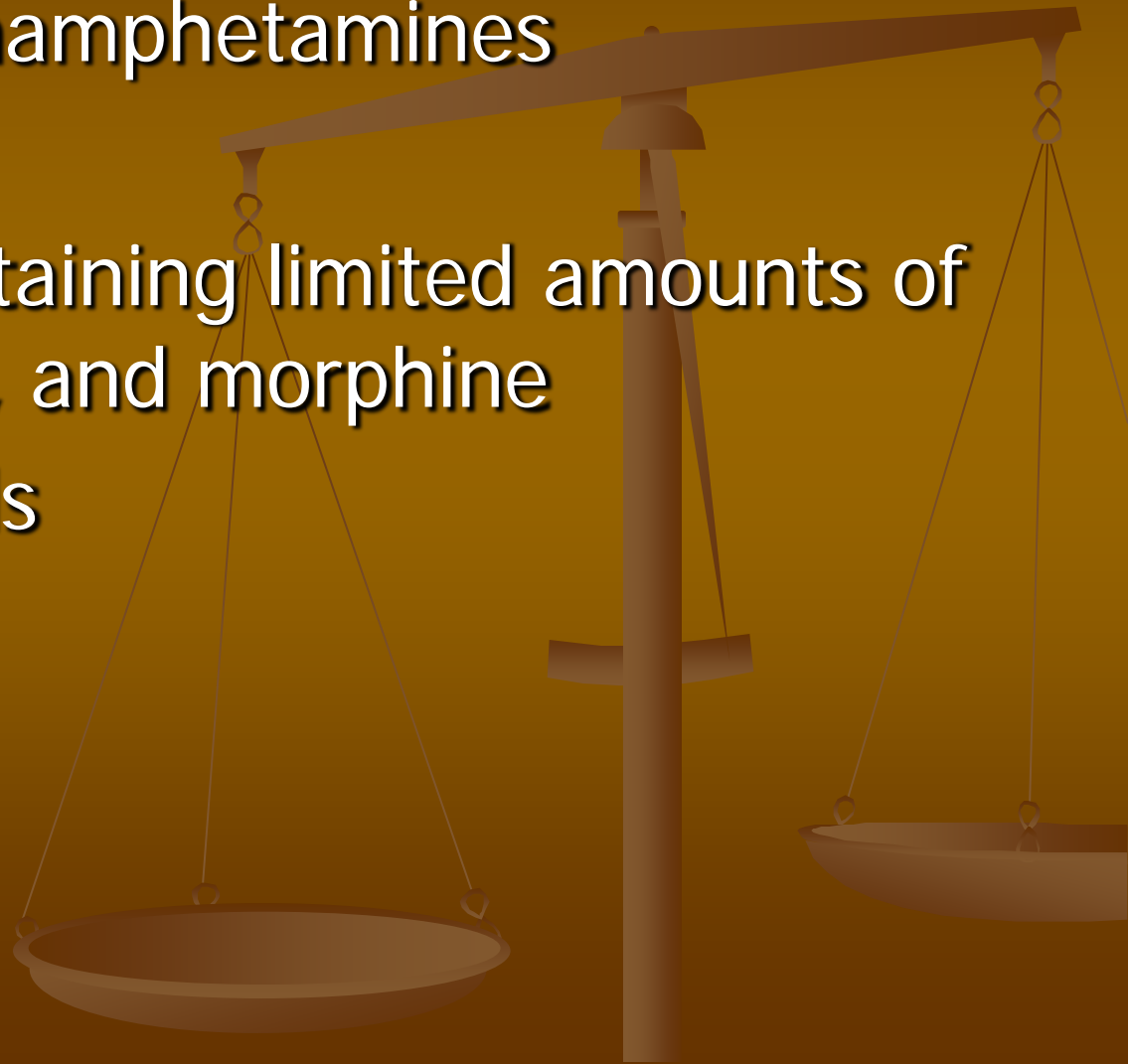
# Schedule III. -

- (A) The drug or other substance has a potential for abuse less than the drugs or other substances in schedules I and II.
- (B) The drug or other substance has a currently accepted medical use in treatment in the United States.
- (C) Abuse of the drug or other substance may lead to moderate or low physical dependence or high psychological dependence.

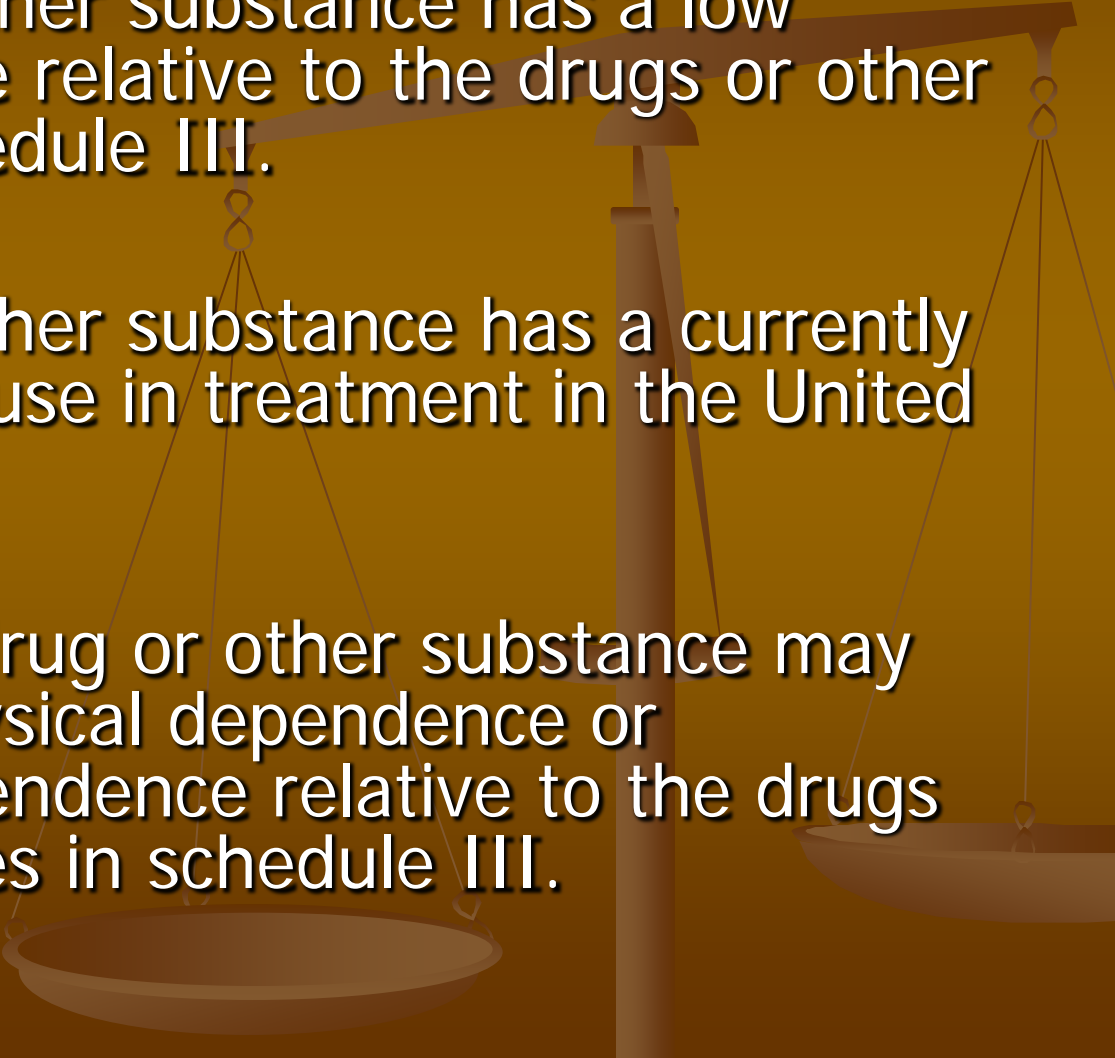


# Examples of Schedule III drugs:

- Non-liquid methamphetamines
- Barbiturates
- Substances containing limited amounts of codeine, opium, and morphine
- Anabolic steroids

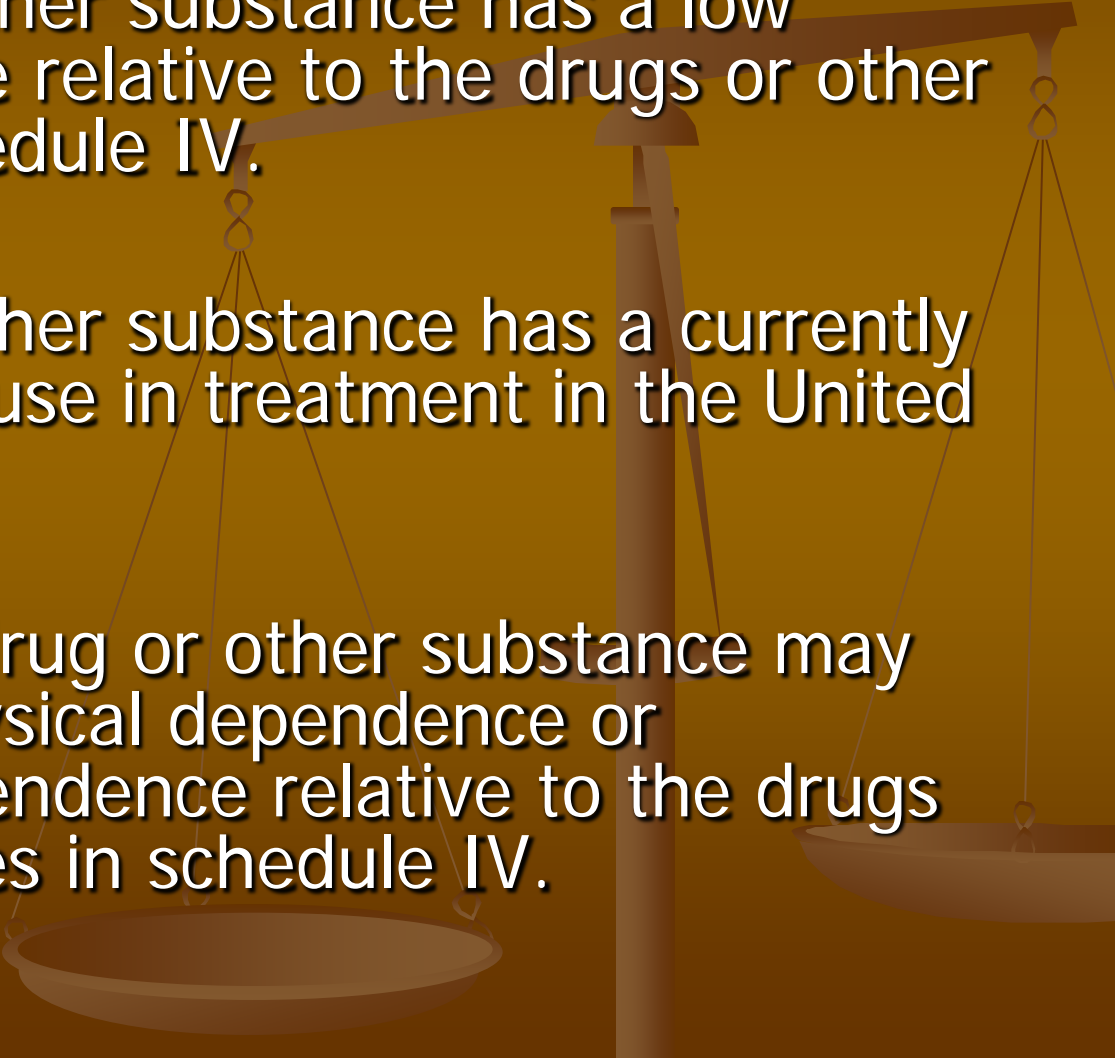


# Schedule IV. -

- (A) The drug or other substance has a low potential for abuse relative to the drugs or other substances in schedule III.
  - (B) The drug or other substance has a currently accepted medical use in treatment in the United States.
  - (C) Abuse of the drug or other substance may lead to limited physical dependence or psychological dependence relative to the drugs or other substances in schedule III.
- 



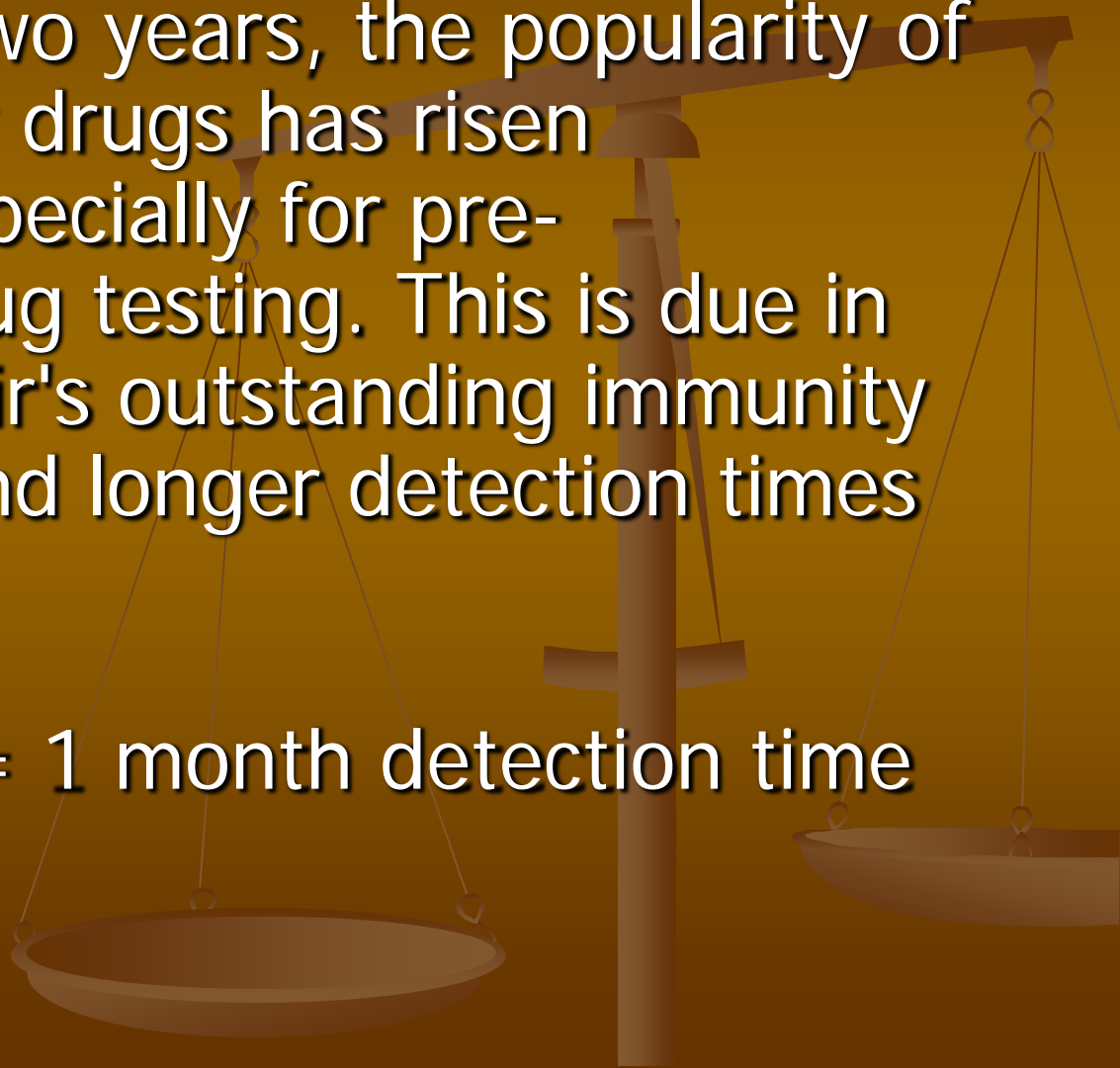
# Schedule V. -

- (A) The drug or other substance has a low potential for abuse relative to the drugs or other substances in schedule IV.
  - (B) The drug or other substance has a currently accepted medical use in treatment in the United States.
  - (C) Abuse of the drug or other substance may lead to limited physical dependence or psychological dependence relative to the drugs or other substances in schedule IV.
- 

# Hair Testing for Drug Use

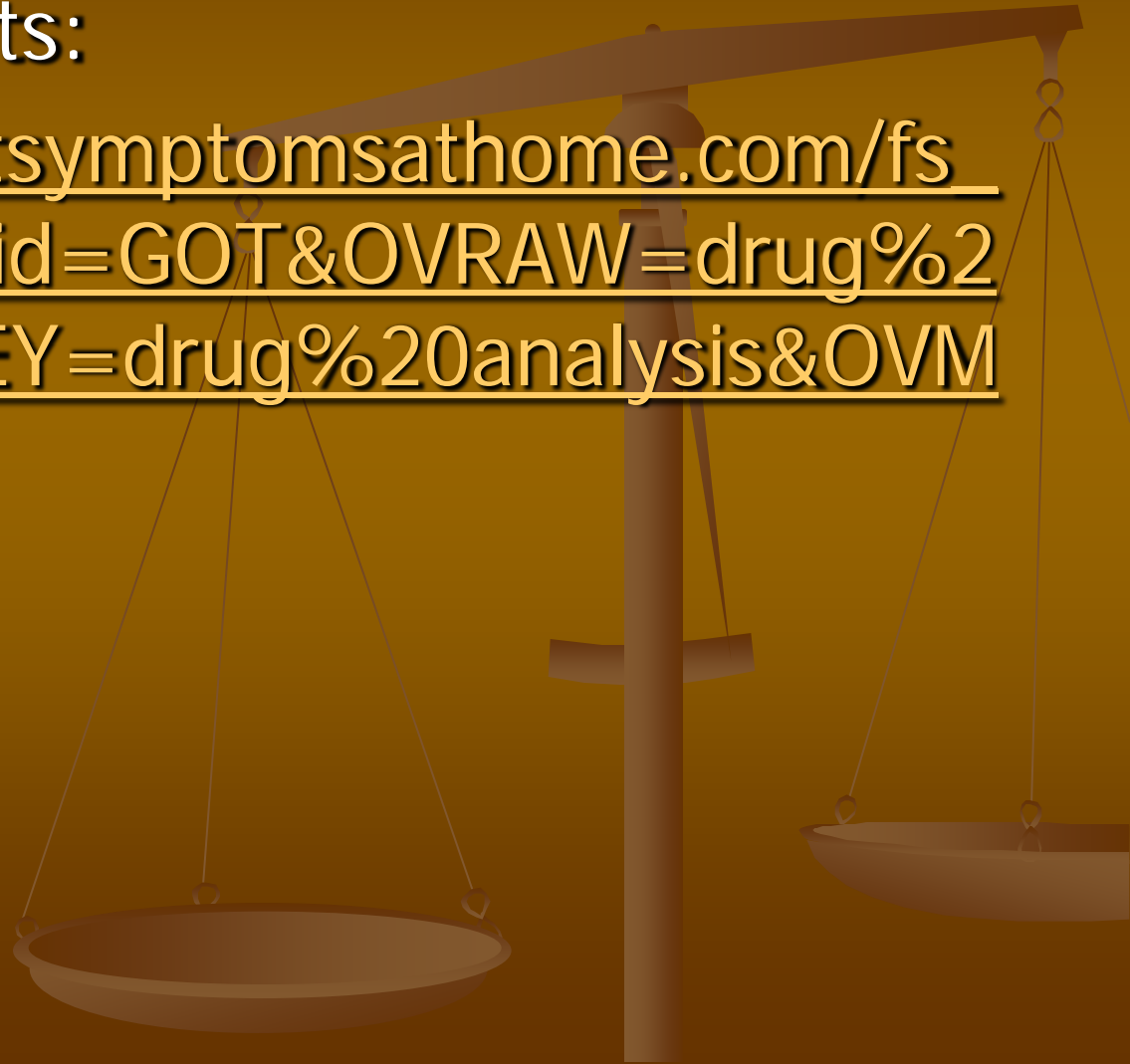
- Over the past two years, the popularity of hair analysis for drugs has risen significantly, especially for pre-employment drug testing. This is due in large part to hair's outstanding immunity to alterations and longer detection times for drugs.

1.0 cm of hair = 1 month detection time for drug(s).



# Home Drug Tests

- Home Drug Tests:
- [http://www.testsymptomsathome.com/fs\\_dru0.asp?portalid=GOT&OVRAW=drug%20analysis&OVKEY=drug%20analysis&OVMTTC=standard](http://www.testsymptomsathome.com/fs_dru0.asp?portalid=GOT&OVRAW=drug%20analysis&OVKEY=drug%20analysis&OVMTTC=standard)



# Drug info...

- GHB & Ketamine – the Date Rape drugs  
<http://www.nida.nih.gov/Testimony/3-11-99Testimony.html>
- Peyote - <http://www.nida.nih.gov/Testimony/3-11-99Testimony.html>
- Ketamine -  
[http://www.drugfree.org/Portal/drug\\_guide/Ketamine](http://www.drugfree.org/Portal/drug_guide/Ketamine)
- Drugs by name -  
[http://www.drugfree.org/Portal/drug\\_guide/ByName/](http://www.drugfree.org/Portal/drug_guide/ByName/)